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Forthcoming Events.

OCTOBER 9TH.

British Foundrymen's Association (Sheffield Branch). — Presidential Address by Mr. Percy Longmuir, B.Met.

OCTOBER 14 AND 15.

Institute of Metals.—Annual meeting at Manchester.

NOTES AND COMMENTS.

Imitation Brass Castings.

The manner in which imitation brass castings, or iron and steel castings that have been plated with brass, have taken their place in modern commerce has been commented on very strongly in trade circles recently, particularly by makers of genuine brass castings who have been adversely affected by the cheaper class of goods. The introduction of the imitation article, especially for cabinet fittings and similar work, has no doubt done a great deal to injure the trade of the brass founder. The speculating builder, too, is familiar with many house fittings, such as hat and cloak hooks, sash fasteners, and numerous other similar ones, that look like brassware to the uninitiated but which are merely iron castings plated with brass. While this is probably affecting for the greater part the plain or japanned ironware formerly used for cheap work, it is probably also to some extent taking the place of genuine brass castings. In any case, brassed-iron is finding greater favour for a host of small fittings, as a visit to any ironmonger's shop will testify, and this is scarcely to be wondered at, considering the low price this class of goods is sold at. To the purchaser who only regards the fact that he is getting what looks like a very substantial brass article this price question is a very great consideration, and it is suggested, too, that many purchasers buy the imitation article under the impression that it is the real thing. Detection is not a very simple matter unless one is on the look-out for substitutes, and as there is no law to compel the seller to properly describe his ware there is room for the suggestion that honesty is not always the practised policy. Now there is nothing particularly bad about a piece of furniture such as those mentioned being of iron with a more attractive finish than that metal presents, otherwise plain or blacked iron fittings of the same style would never have taken the place they have done; but, from the brassfounder's point of view, it is a question of unfair competition. Of course, if a purchaser buys the plated article under misapprehension, time will probably supply him with the truth, particularly if the goods are subject to a little wear and a damp atmosphere. The corrosive tendencies of the iron not infrequently display themselves after a while, despite the plating of brass or bronze, and then considerable dissatisfaction is felt and expressed. In the meantime the brassfounder's article has not been required.

But apart from the question of how brassed-iron goods compete with solid brassware, it is fairly well established that there is a large market for plated castings, especially in the way of house fittings, on account of the low price as compared with solid brass goods, and this demand is not likely to diminish; but there will also always be a certain demand for solid brass fittings for good work, as they take a higher finish and last longer. The seller, too, will find it to his advantage to sell his goods under their

proper descriptions rather than mislead his customers. There is one certain safeguard that can be easily applied, and which defies the deception of a perfect brass finish—the application of a magnet to the article will show at once whether the metal is iron or not. Incidentally, it may be mentioned that the majority of these brassed-iron goods are imported from America, and this is probably the source of the English brassfounder's grievance. But it may be asked whether our ironfounders cannot also produce these goods and offer them to the home customer. The demand for the goods exists, and is likely to increase, since iron is so much stronger and more suitable for a number of purposes than brass. It would be better to meet competition by business enterprise than to complain of unfairness and wait indefinitely for some law to right the matter.

Mixing Cast Iron and Steel to get Dense Castings.

In some German foundries it is customary, in cases where much importance is attached to the density of the castings (as, for instance, in casting steam cylinders, etc.), to add to the native pig-iron some English, the composition and method of manufacture of which is foreign to Germany. It differs from the ordinary German pig-iron principally in that while containing silicon and manganese, it has, for cast iron, a very low percentage of carbon. Attempts to make such pig-iron in Germany have failed, because in the making first the manganese, then the silicon, and, finally, the carbon, burns, and the subsequent addition of manganese and silicon to this low-carbon iron by ferro-manganese and silicon iron, as is usual in steel-making, would be too expensive. Benefit may, however, be derived from the addition to the pig in the cupola, for the purpose of getting dense castings, of steel scrap. An exact control of the quality of the iron, and, therefore, a guarantee for the density and quality of the castings, is by this process not yet possible. This uncertainty results principally from the high melting temperature of the steel, which must first gain carbon in the furnace, and melts more slowly than the pig. The tapped-off mixture is, therefore, never twice of the same composition; the different ladles of metal from the same charge vary in composition, and the castings, also, are therefore different.

In order to get a thoroughly homogeneous mixture of the melted iron and steel, so that one can reckon with certainty on homogeneous dense castings, Hennig of Mannheim has suggested first to make an intermediate product, which is about equal to the English material; that is, which will melt at the same time as the ordinary German pig-iron and mix intimately therewith, as it will have about the same melting point. For the manufacture of this intermediate product, which is cast in pigs and brought as such to market, ordinary melted pig is mixed with the melted steel, and as thoroughly as possible stirred. This product can, for instance, consist of 40 per cent. of steel and 60 per cent. of pig-iron. If, now, the steel contains 0.60 per cent. of carbon and the pig-iron 3.50 per cent., there will result a mixture of iron and steel containing 2.34 per cent. of carbon. Of this intermediate product, with a carbon content of 2.34 per cent., 30 parts may be mixed and melted with 70 of ordinary pig with a carbon content of 3.6; the final product will contain a total carbon percentage of about 0.7 + 2.52, or 3.22 per cent. A mixture of 40 parts of the intermediate product with 60 of pig will give 3.09 per cent. carbon. In order to get a good mixture, it is necessary that the pig be brought to the melting temperature of the steel, which is well known to be about 300 degrees C. (=540 F.) higher than that of pig-iron. The increase of the specific heat from the melting temperature of the pig (about 1,100 degrees C. = 2,012 degrees F.) to that of steel (about 1,400 degrees C. = 2,552 degrees F.) from 0.2 to 0.4, results, according to Hennig, in a material saving in heating units; but the particular advantage is that the mixture ensures a dense casting.

Estimating the Weight of Castings.

Estimating the weight of castings according to that of the pattern is a very risky business, as the wood of which the patterns are made varies considerably in weight, according to the rapidity of its growth and the thoroughness with which it is dried. Other things being equal, the more slowly wood grows, the greater is its specific gravity; thus, Canadian and Archangel pines are of greater density than that from the southern or even the middle parts of North America. The following table, giving the specific gravity of several kinds of wood (air-dried and fresh cut), goes to show how much variation there may be between the calculated and the actual weight of a casting, when figured up beforehand, from the weight of the pattern:—

	Specific gravity.	
	Air dried.	Fresh cut.
Apple	0.66 to 0.84	0.95 to 1.26
Basswood (Linden)	0.32 to 0.59	0.58 to 0.87
Cedar	0.57	—
Fir	0.31 to 0.76	0.38 to 1.08
Mahogany	0.56 to 1.06	—
Maple	0.53 to 0.81	0.83 to 1.05
Oak	0.69 to 1.03	0.93 to 1.28
Pitch-pine (so-called)	0.83 to 0.85	—
Red Pine	0.35 to 0.60	0.40 to 1.07
Walnut	0.60 to 0.81	0.91 to 0.92
White or yellow pine	0.37 to 0.75	0.77 to 1.18

There is a further variation in the weight of the castings, according to whether or not the pattern is well rammed. The thinner the pattern in proportion to its diameter, the greater this variation, and the more the casting will weigh. On top of all this are to be considered further factors influencing the weight of the casting, such as the kind of iron and the amount of "feeding" that is done while pouring. Many of these variables may be eliminated when gauging the cubic contents of the pattern by immersing it in a full vessel of water and observing how much water it displaces. If the pattern is very large, a tank of known cross-section can be used with a scale marked on the inside, and the rise in the level of the water observed; from this the cubic contents of the pattern may be calculated to a nicety. Average cast iron will perhaps run about 7.25 specific gravity; that is, about 450 lbs. to the cubic foot when solid and cold.

Figuring from the weight of the pattern is like the old-fashioned way of getting at the weight of a pig by balancing him on a rail against a stone, and then guessing at the weight of the stone.

The Growth of Cast Iron.

At the annual London meeting of the Iron and Steel Institute, at the close of last month, among a number of important papers which were read was one on "The Growth of Cast Irons after Repeated Heatings," by Professors H. F. Rugan and H. C. H. Carpenter. The joint authors of the paper are sufficiently well known as authorities on metallurgical matters to give their conclusions great weight, and we may consider it a matter for congratulation that the subject has been taken up so thoroughly by such investigators. The researches of Mr. A. E. Outerbridge, Jun., of Philadelphia, on the subject have received all too little attention in this country, and it is encouraging to find such exhaustive investigations as those now recorded being carried on. Unfortunately, owing to considerations of time and space, we are unable to present the paper in this issue, but will deal fully with it next month.

The Edgwick Works, Coventry.

The foundry and branch works of Messrs. Alfred Herbert, Limited, are situated in the Foleshill district of Coventry, some 2¾ miles from their principal works at "The Butts." The site, though a good one, was not altogether a matter of choice, all the available space at the Butts Works being covered and no adjacent land being available. When further extensions became necessary the Company had therefore no option but to go out of the city to find a suitable position for their new works and to duly provide for future extensions as such become expedient. A site consisting of some six acres of land on the Foleshill Road, which is served by the canal and is also in close proximity to the railway station, was accordingly secured.

The works at present erected cover about half of the available land; the plans, however, provide for the complete occupation, so that future extensions, which will be made from time to time, will form part of the original scheme rather than additions to existing works. This feature will be readily appreciated by those who may have been connected with a growing works, to which additional shops have from time to time been added, rendering the best economy a matter of extreme difficulty and complete continuity of operations a practical impossibility.

The Edgwick Works are approached through a gate-way entrance, on the right of which are the time-keeper's and weighing clerk's offices, and on the left the general offices comprising clerks' office, drawing office, testing department, laboratory, etc. The foundries and auxiliary shops form the other three sides of a square, the centre of which is used as a stocking yard for raw material. The works lie to the rear of the foundries, the whole being linked up with a narrow-gauge railway which is served by a small locomotive and train of trucks.

There are two iron foundries, devoted respectively to the production of large and small castings. The large foundry, where nothing but dry sand castings are made, is 80 ft. by 120 ft. The floor is commanded by a 5-ton overhead electric crane, and is further served by a number of jib cranes placed in convenient positions. There are four coke-fired ovens, the carriage for the larger of which runs upon a broad-gauge track, and is worked into and out of the oven by a hand-wheel operating a worm-wheel and pinion. The castings for turrets, and in fact all special work, are made in heated iron moulds, open on the one side; the result of this method is that beautifully clean close-grained castings are produced. For repetition work special mould boxes are retained for each job; all the smaller sizes are jig drilled, and have machined faces, so as to be entirely interchangeable. Melting

FIG. 1.—INTERIOR OF FOUNDRY FOR LARGE WORK; EDGWICK WORKS.

in the large foundry is done in a No. 5 Thwaite cupola, fitted with a receiver, which type of cupola is too well known to require any special description. It should be noted the receiver forms a very important adjunct, its capacity being about that of the hourly melting capacity of the furnace. The hot-air pipe between the receiver and the cupola provides for a free circulation of hot air, preventing any possibility of the metal chilling. The small foundry is 170 ft. by 64 ft.; here green sand moulding only is carried on. The moulding floor is served by a 3-ton manual crane (Messrs. Vaughan & Son), and the equipment includes five Tabor moulding machines, operated by compressed air. The cupola is a No. 4 Thwaite constructed with a receiver similar to the cupola in the large foundry. The output of the two foundries is about 80 tons per week. Analysis is taken of all pig-irons used, and two 12-in. test bars are made from every cast, careful records being kept of contraction, depth of chill, and shearing strength. This last test is made on a Denison machine. Foreign scrap is practically absent from the stock yard, and we understand that with the exception of car wheels and ingot moulds, the composition of which is known, none is used.

The brass foundry, which contains five furnaces, is 95 ft. by 32 ft., and is equipped with the usual auxiliaries, including a Tabor moulding machine. The fettling shop is 120 ft. by 32 ft., and adjoins an orderly arranged castings stores 190 ft. by 32 ft., the floor of which is served by a 3-ton overhead crane. Upon the far side of this shop is the bar store, which is 180 ft. by 30 ft.

A compressed air system is installed throughout the foundries, and the machinery generally is operated by electric motors. The present generating plant at the foundry supplies current at 110 volts. Current, however, is also being taken from the works' power house at 220 volts, and reduced to 110 volts for use in the foundries. Eventually the whole of the energy will be supplied from the works' central station, and the present plant at the foundry be discarded.

The works, which are mainly devoted to the production of milling machines, consists of ten bays having 30-ft. centres, and of which Nos. 1 to 8 are 100 ft., No. 9, 200 ft., and No. 10, 110 ft. long respectively. One end of the shop, the direction in which future extensions will be made, is of a temporary nature. The roof is of particularly light construction, having to support merely its own weight. The line shafting and also the crane runways are supported from the floor upon braced steel girders, built into the floor foundations. The bays for the heavy machines are each served by a 3-ton Broadbent electric crane. The whole of the bays having, however, common centres, a change over from light to heavy machines in any one bay or bays, even to the crane equipment, is a very simple matter.

The machines, many of which are of the automatic type, are arranged in groups, each group being operated through line shafting by a separate motor. Heating and ventilation is on the Sturtevant system, by which system the air in the shop can be completely changed within a space of seven minutes with a total absence of draft. The hardening shop is equipped with a Brown & Sharp coke-fired furnace, and also a small gas-fired furnace.

The power house contains a 300-h.p. direct-coupled generating set, the engine being of Messrs. Robey & Company's well-known compound condensing type. Provision is made alongside this set for the installation of further similar units when such become necessary. Steam is raised in a battery of Babcock & Wilcox boilers fitted with mechanical stokers and Babcock & Wilcox superheaters. The working pressure of the boilers is 150 lbs., and sufficient superheat is imparted to the steam to insure its being delivered dry at the engine stop valve.

FIG. 2.—SCRAP SHED AND LOCOMOTIVE; EDGWICK WORKS

MESSRS. WM. GEIPEL & COMPANY, of the Vulcan Works, St. Thomas' Street, London, S.E., are just placing on the market two economical turn-down electric lamps, styled the "Economical Pull String Type," and "Hyloe Long Cord Type."

IN view of the extent to which they find their trade in balata and other beltings with the United States handicapped by the high tariff, the directors of R. & J. Dick, Limited, of Glasgow, have decided to establish a factory in that country.

Cleaning Castings by Sand Blast.

In bygone days, when speaking of the cleaning room of a foundry, one usually referred to some dingy, dark corner space allotted to the operation of cleaning castings. The slow, unsatisfactory and costly hand method of cleaning castings has, however, now given place in first-class foundries to a much more economical mechanical method, and from a series of exhaustive experiments with the earlier primitive glass frosting sand-blast apparatus, a plant has been perfected which gives excellent results.

The initial experiment consisted of merely placing the sand-blast apparatus and workers inside a specially constructed chamber in which the cleaning was effected. Later, arrangements were made to purify the atmosphere of the chamber by exhausting

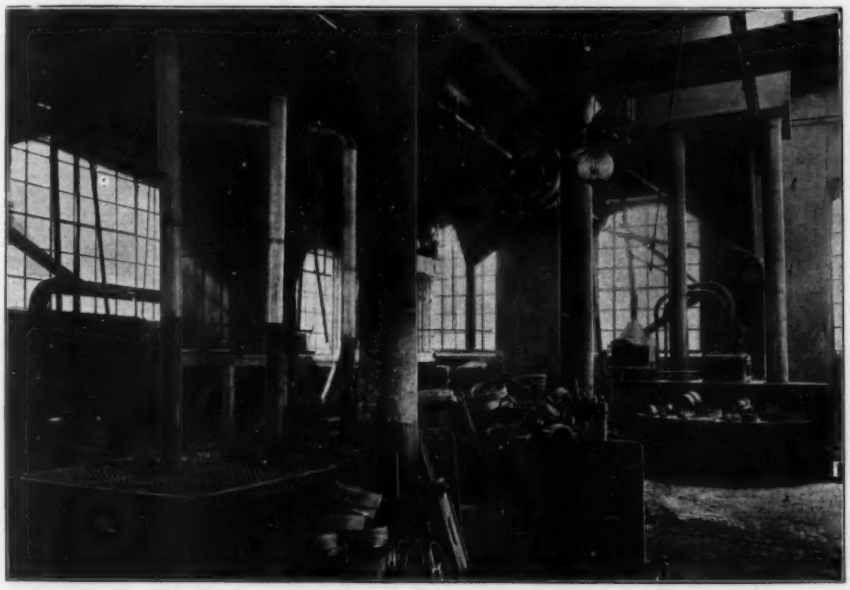


FIG. 1.—CLEANING ROOM IN A MODERN FOUNDRY.

the dust therefrom, and so improve the working conditions of the operators, and to-day many plants are working with a combined exhaust arrangement connected to all departments wherein dust is created, so that the exhaust pipes from each arrive at the same junction and are led off by one main. Contrast the difference of the conditions under which work is performed by modern methods in purified atmosphere and the former dirty state of the so-called cleaning place in the old-fashioned foundry, and the improvement becomes apparent.

Fig. 1 presents a view of the cleaning room in an up-to-date foundry. This is an installation fitted with all the latest appliances for cleaning castings with the greatest rapidity yet obtainable, and, at the same time, freeing the air as much as possible from dust. Immediately in front is seen the cleaning bench, fitted with strong perforated plates, through which the refuse falls into receiving hoppers underneath. The three vertical galvanised pipes also shown are exhaust pipes, which deal with the dust caused during the cleaning operation. On the left are the emery grinders for fettling the castings, each fitted with a dust exhauster. In the background is a rotary-table sand-blast apparatus, an installation of which is shown to better advantage in Fig. 2, and a detailed description of the working of which follows.

As already mentioned, the first sand blasts were very simple, and were mostly used only for frosting glass surfaces, and not until the introduction of the rotary table, which possesses so many advantages for cleaning iron castings, did the employment of the sand blast become at all general. Generally these rotary tables are constructed entirely of iron, and have a vertical shaft with table resting firmly in a toe bearing. The rotary movement of this table is sufficiently slow for the operator to place any castings to be cleaned in position, turn or remove them whilst it is in motion. In consequence of the exceedingly powerful blast produced by the two-pressure sand-blast apparatus, shown on the left in Fig. 2, it is only necessary to pass the castings once or twice under the sand blast to thoroughly clean their exposed surfaces.

It is well known that the object sought in all sand-blast plants is to obtain as far as possible continuous working, combined with a powerful blast. Whilst the latter is obtained by using the pressure system, continuous working is obtained by the two-pressure apparatus shown on the left in Fig 2. This apparatus consists of twin chambers side by side (A and B), and whilst one chamber (A) is under pressure, B is being automatically filled with sand, and when the chamber A empties, the contents of B are brought into use by simply reversing the lever, and thus continuity of working is secured. The sand stream is carried by fixed piping to the rotary table, and at this point it attains its full power

and is discharged through one or more nozzles swinging above the table.

The articles to be cleaned and finished are placed on the slowly rotating table, which carries them past the rubber curtains to the inside of the case, where under swinging nozzles they are subjected to the full force of the powerful sand blast; upon returning again before the curtain, they are either turned or removed, and others replace them, as may be necessary, whilst the table revolves.

A striking feature of this apparatus is the absence of dust in the cleaning room, as the dust produced by the shattering of the sand is drawn away by a powerful exhauster. But the sand itself is still useful and falls through the grids of the table on to a slide that carries it to an elevator at the rear of the

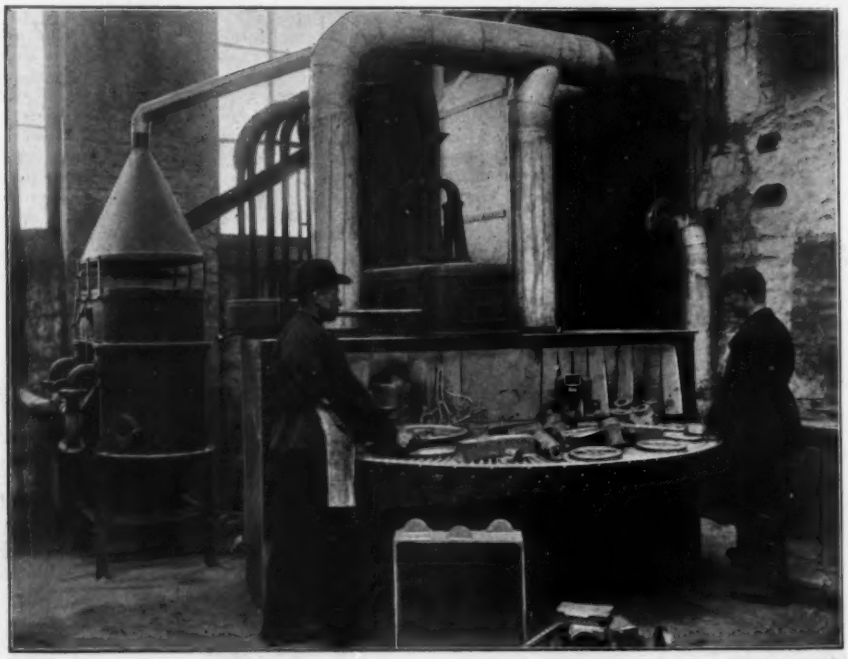


FIG. 2.—ROTARY SAND-BLAST APPARATUS.

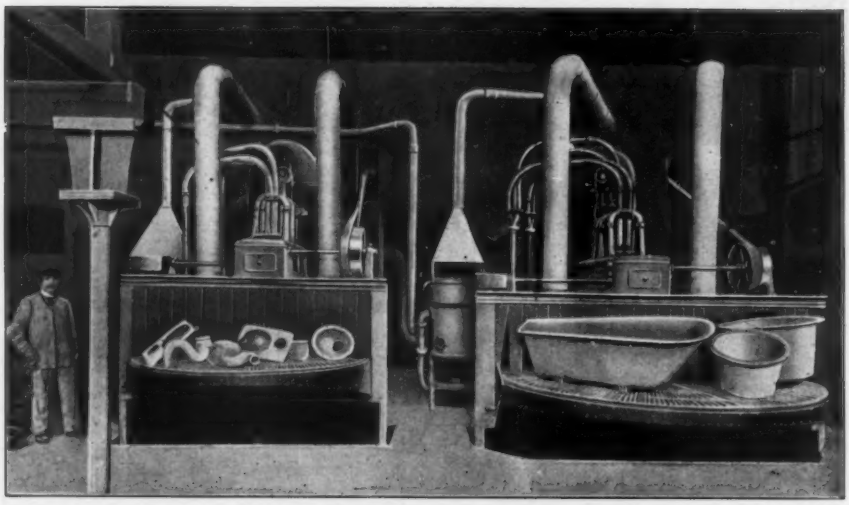


FIG. 3.—SAND-BLAST APPARATUS FOR REMOVING SCALE FROM BATHS AND OTHER LARGE CASTINGS.

table, which in turn discharges it through a shoot on to a sieve on the top of the two-pressure apparatus. This latter is provided with a dust hood to draw away the dust caused by the falling sand.

Another type of rotary table sand-blast plant is shown in Fig. 3, which is a good example of the development attained by the sand-blast in foundry work. This plant is for cleaning and removing scale and enamel from very large castings, in the present instance baths, furnace pans, and sanitary castings. The table on the right has a diameter of 9 ft. 10 in. and a passage of 30 in., *i.e.*, it will take castings up to 30 in. deep. The sand blast is discharged simultaneously through three nozzles which are swinging above the rear part of the table, and so arranged that the whole of the table is evenly strewn.

FIG. 4.—SAND-BLAST TUMBLING BARREL.

Of equal importance for many foundries is the sand-blast tumbling barrel, as shown in Fig. 4, which is especially suitable for small castings, such as electric, gas and water fittings, etc. The motion is sufficiently slow to enable the operator to charge the drum and place the cover in position whilst it is in motion. The castings are usually allowed to remain in the barrel about 10 minutes, when the cover is removed and they are automatically discharged onto a slide and through the outlet into a receptacle placed underneath.

The plant works without dust, this being drawn away by a powerful exhauster, whilst the sand falls through the perforations of the drum and outlet slide into a conveyor, and from thence to an elevator, which discharges it into the two-pressure apparatus for further use.

Another useful machine is the two-pressure sand-blast apparatus on the single chamber system, shown in Fig. 5. This is used when, owing to the size or weight of the castings, they cannot be cleaned on a rotary table, transportable table, or other special machine, or where continuous operation, as provided with the twin-chamber apparatus, is not required. The apparatus consists of a single sand chamber, ending in a funnel, with a mixing pipe, and also a sand-filling valve and air cock. The two latter are outside the apparatus and easily accessible. To gain access to the inside of the chamber, hand holes are provided, with sights to see the height of the sand. The quantity of sand falling into the mixing pipe is regulated by exchangeable bushes. The top is covered by a removable sieve, which retains any pieces of metal or stones that may be in the sand.

It is customary when using a machine of this type to attach a flexible blast pipe to the mixing pipe, so that the operator can thoroughly blast all parts of the casting. When sand blasting in the open, he should be provided with goggles to protect his eyes from the rebounding sand, or a special room can be provided fitted with dust-exhausting arrangements.

This apparatus, we may mention, is also used very successfully for cleaning ships' sides and bottoms.

FIG. 5.—SAND-BLAST APPARATUS, CONSTRUCTED ON THE TWO-PRESSURE SINGLE CHAMBER SYSTEM.

For such a purpose it is fitted on a special portable trolley. The latest construction comprises a complete portable sand-blast plant, built on a truck, and it is especially designed for cleaning bridges, iron structures, etc., before repainting. The air compressor, which forms part of it, is driven by an internal combustion petrol engine, and the truck carries the complete plant, comprising petrol engine, air-compressor, air-receiver, and sand-blast apparatus.

In conclusion, we may add that in cleaning grey iron castings the air pressure used is about 15 lbs., and for steel castings, etc., about 30 lbs. All the foregoing plants and machines as described are made throughout by the London Emery Works Company, Park, Tottenham, London, N.

THE ARDEN ENGINEERING WORKS AND FOUNDRY, Teuton Street, Halifax, were recently put up for sale by auction. The premises comprise a workshop 120 ft. by 64 ft., with north shed lights and plank floor, machinery, show-rooms, drawing, principal's and clerks' offices, and also a large pattern shop. The foundry is fitted with cupola, separate office, store-room, and four overhead travelling cranes. The shops and offices are heated by hot water. There was no offer made for the works.

The Air-Furnace Process of Preparing White Cast-Iron for the Malleablising Process.*

By Henry M. Howe and Enrique Touceda.

This paper gives particulars as to the composition of the iron and slag at different stages in the "air-furnace" process of preparing white cast-iron for conversion into malleable cast iron by annealing. The details of the operation are given later. Attempts had been made to induce some chemists in a malleable-iron works to make such an investigation, as this would involve the advantage of the greater familiarity with the conditions which one habitually on the spot must have. Failing this, however, the samples here represented were taken with such fairness as the conditions permitted. The results are shown in Table I., and graphically in Figs. 1 and 2.

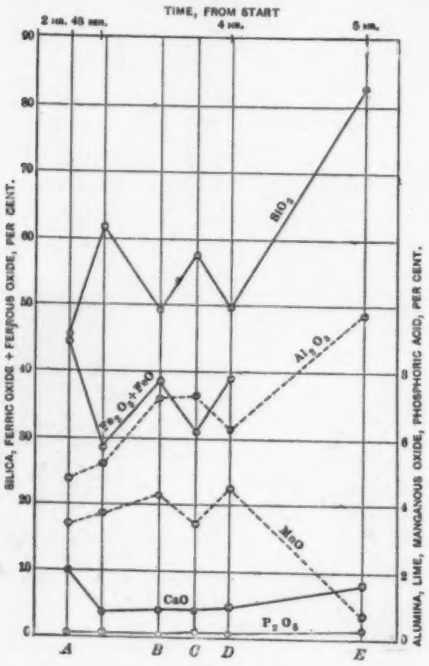


FIG. 1.—COMPOSITION OF SLAG IN AIR-FURNACE PROCESS.

A. Charge not fully melted at throat; metal and slag sluggish. *B.* Not yet all melted at throat; almost no boiling *C.* Nearly all melted. *D.* Nearly all melted; a little mushy. Slag now skimmed. *E.* New slag formed spontaneously.

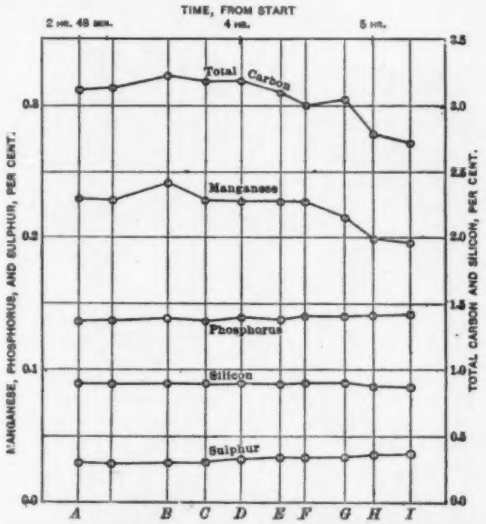


FIG. 2.—COMPOSITION OF IRON IN AIR-FURNACE PROCESS.

A. Charge not fully melted at throat; metal and slag sluggish. *B.* Not yet all melted at throat; almost no boiling. *C.* Nearly all melted. *D* Nearly all melted; a little mushy. Slag now skimmed. *E.* Pours thin. *F.* First of melter's sample. *G* Last of melter's sample; new slag formed spontaneously. *H.* Begin pouring 5 min. after this. *I.* Charge nearly finished, as indicated by much sparkling; 5 min. later, all out.

TABLE I.—*Removal of the Foreign Elements in the "Air-Furnace."*

Sample No.	Time After Charging, 7.30 a.m.	Composition of Metal.					Composition of Slag.									Remarks.
		C.	Si.	Mn.	P.	S.	SiO_2.	Fe_2O_3.	FeO.	Al_2O_3.	CaO	MgO.	MnO.	P_2O_5	SO_3.	
	Hr. Min.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	
1	2-48	3.10	0.89	0.227	0.136	0.029	45.59	3.31	40.32	4.74	1.99	trace	3.40	0.09	trace	Charge not fully melted at throat; metal and slag sluggish
2	3-03	3.12	0.89	0.227	0.137	0.029	61.54	3.27	25.50	5.18	0.75	trace	3.69	0.11	trace	
3	3-28	3.21	0.89	0.240	0.138	0.029	49.24	6.28	32.23	7.20	0.84	trace	4.27	0.12	trace	Not yet all melted at throat; almost no boiling.
4	3-45	3.16	0.89	0.227	0.136	0.029	57.67	2.95	27.94	7.25	0.84	trace	3.39	0.16	trace	Nearly all melted.
5	4-1	3.17	0.89	0.227	0.139	0.032	49.24	5.50	33 65	6.26	0.91	trace	4.59	0.14	trace	Nearly all melted—a little mushy. Slag now skimmed.
6	4-19	3.08	0.89	0.227	0.137	0.033	—	—	—	—	—	—	—	—	—	Pours thin.
7	4 30	3.00	0.89	0.227	0.140	0.033	—	—	—	—	—	—	—	—	—	First of melter's sample.
8	4-48	3 03	0.89	0.214	0.140	0.033	83.60 80 80	—	4.94 6.45	9.49 10 00	0.83 2 30	trace	0.92 0.38	0.18 0.21	trace	Last of melter's sample. New slag formed spontaneously.
9	5-1	2 78	0.87	0.199	0.141	0.034	—	—	—	—	—	—	—	—	—	Begin pouring 5 minutes after this.
10	5-17	2.71	0.87	0 195	0.141	0.035	—	—	—	—	—	—	—	—	—	Charge nearly finished, as indicated by much sparkling. 5 minutes later, all out.

Remarks on the Samples.

At the time when the first two samples were taken, the metal and slag were still too sluggish to permit fair sampling, and not until sample 6 were the conditions really favourable, because at the time of

* Transactions of the American Institute of Mining Engineers.

the fourth sample the metal was not fully melted, and even at the time of sample 5 it was still sluggish. Indeed, the slag was probably very heterogeneous throughout, because it took up silica and alumina rapidly from the bottom, and because it was so silicious as to eb sluggish at this relatively low temperature. This heterogeneousness is exaggerated in the two samples of slag 8, apparently by the great viscosity due to its extraordinary acidity. It is to be noted that the manganous oxide of one sample is about two and one-half times that of the other, and that the lime varies still more. Moreover, the great variations in the silica- and iron-oxide content of the other slags evidently represent rather the unevenness of the slag itself and the effect of additions of silica and alumina from the bottom, than the transfer of silicon from metal to slag and back again. But the great change between slags 5 and 8 represents the fact that, immediately after taking sample 5 all the slag was skimmed off, so that slag 8 is a new one formed spontaneously and, evidently, mainly by the corrosion of the bottom.

Whatever allowance must be made for the heterogeneousness of the slag, the internal evidence goes to show that the sampling of the iron after the charge had been thoroughly melted was accurate. This is evidenced by the slight but fairly regular increase of the phosphorus content, representing the decrease of the weight of the charge by the slagging of the iron; the still greater increase of the sulphur content—greater when reckoned in percentage of the initial sulphur content—representing this same slagging of the iron, together with a slight absorption of sulphur from the furnace gases; and the almost perfect uniformity of the silicon content.

The increase of carbon between the samples 1 and 3 may be due to the progressive melting of the pig-iron. At the time when samples 1 and 2 were taken some iron remained unmelted. As this later melted it naturally changed the composition of the molten bath. Now the fact that this change was in the direction of increasing the carbon content indicates that the loss of carbon in melting was greater in the case of the iron which melted first than in that which melted later, perhaps because the former melted more slowly than the latter, as would naturally be the case. It is to be noted that, in the same way, sample 3 contains a little more manganese than samples 1 and 2.

The surprising thing in these results is the constancy of the silicon content from sample 1 to sample 8, followed by only a very slight decrease between samples 8 and 9. It is extremely improbable that any combination of self-compensating errors should result in such uniformity of silicon content. This constancy in the samples 6, 7 and 8, all taken after the iron had melted, agrees with the constancy from the samples 1 to 5, when some of the iron was still melting, so that the removal of the silicon seems to have been extremely slow during the relatively large decarburisation of the first melting part of the iron, during the slighter decarburisation of the later melting iron, and while the whole lay fully molten on the hearth.

Why does the silicon content remain so constant? Partly, at least, because it is so small relatively to the carbon content. Such constancy is certainly extremely rare in the acid Bessemer and acid open-hearth processes; but where the silicon content decreases very slowly in these, there it is, in general, very small.

To throw light on this point, we have condensed in Table II. data from all the investigations of which we know, that show the progress of the removal of the several non-ferrous elements in the acid open-hearth process. For sake of comparison, case No. 1 gives data concerning an acid Bessemer heat, in which the removal of silicon was decidedly less than in any other of which we know. In this case the initial silicon content was unusually low, and the initial temperature unusually high.

TABLE II.—*The removal of silicon as affected by the Silicon-Content, and by the Ratio of the Carbon Content to the Silicon Content.*

Process.	Number of Case.	Silicon.			Carbon.		C / Si	Loss of C + Loss of Si.	Ore Added or Not.
		Quantity in Initial or First Sample Recorded.	Next Sample: Time After Initial (or after First Sample).	Next Sample: Loss of Si in Per Cent.	Quantity in Initial or First Sample Recorded.	Next Sample: Loss of C at Time of Next Sample.	Initial Ratio		
Acid Bessemer.	1	Per Ct. 0.70	3 min.	Per Ct. 0.14	Per Ct. 3.65	Per Ct. 1.15	5.21	8.2	—
Acid Open Hearth.	2	0.02	—	0.00	0.54	0.41	27.0	∞	Yes
	3	0.09	—°	0.05	2.19	2.13	24.3	42.6	Yes
	4	0.01	—	0.00	0.18	0.10	18.0	∞	Yes
	5	0.121	1 hr.	0.088	2.00	0.25	16.5	2.8	Yes
	6	0.28	1 hr. 30 min.	0.01	3.6	0.26	12.9	26.0	No
	7	0.05	—	0.04	0.64	0.52	12.8	13.0	Yes
	8	0.03	—	0.01	0.36	0.28	12.0	28.0	No
	9	0.07	—	0.05	0.61	0.53	8.7	10.6	Yes
	10	0.04	—	0.01	0.32	0.24	8.0	24.0	Yes
	11	0.54	55 min.	0.01	3.6	0.2	6.7	20.0	No
	12	0.09	—	0.07	0.57	0.49	6.3	7.0	Yes
	13	0.50	1 hr.	0.25	1.9	0.1	3.8	0.4	—
	14	0.611	1 hr.	0.242	2.20	G'n 0.10	3.6	—	Yes
	15	0.70	20 min.	0.24	2.15‡	0.31	3.1	1.3	Yes
	16	1.19	1 hr. 25 min.	0.40	2.70	0.08	3.1	0.2	No
	17	0.59	30 min.	0.00	1.66	0.06	2.8	∞	No
	18	1.38	—	1.36	3.81	0.81	2.8	0.60	No
	19	1.48	1 hr.	0.83	3.21	0.33	2.2	0.40	—
	20	1.10	30 min.	0.36	2.46	0.61	2 2	1.7	—
	21	0.78	35 min.	0.43	1.60‡	0.06	2.1	0.14	Yes
	22	0.80	40 min.	0.52	1.60‡	0.02	2.0	0.04	Yes
	23	0.756	30 min.	0 263	1.38	0.00	1.8	—	No
	24	0.77	7 hr.	0.42	1.30	0.50	1.7	1.2	No
	25	1.350	—	1.154	1.755	0.1	1.3	0.09	Yes
	26	0.480	7 hr.	0 330	0.497	0.437	1.04	1.32	No
	27	1.60	30 min.	0.690	1.34	0.00	0.84	—	—
	28	1.281	30 min.	0.163	1.00	0 00	0.78	—	—
Air-Furnace.	29	0.89	2 hr.†	0.00	3.10	Gain 0.02	3.5	—	No

° The initial sample was taken after the first addition of ore, and the "next sample" at tapping time.
† The silicon-content remained constant for two hours.
‡ Reported as combined-carbon.

In every case in Table II. in which the removal of silicon between two successive samples is either zero or very small, the silicon content itself is very small, either absolutely or relatively to the carbon content. To the former class belong cases 2 to 5 inclusive, 7 to 10 inclusive, and 12, in none of which is the initial silicon content greater than 0.121 per cent. To the latter class belong cases 6, 11, and 17, which have respectively 12.9, 6.7, and 2.8 times as much carbon as silicon to start with.

Of course, the silicon content and its relation to the carbon content do not alone determine the order of removal of silicon and carbon. For instance, in cases 14 and 15, though there is but little silicon present, 0.60 per cent. in one case and 0.70 per cent. in the other, and though there is more than thrice as much carbon present as silicon, yet the removal of silicon is very considerable. It is well known that a low temperature favours the oxidation of the silicon rather than of the carbon, and so does basicity of slag. The influence of basicity is shown clearly when we pass to the extreme case, that of the basic open-hearth process, in which the silicon is removed very rapidly. In case 15, though the slag nominally con-

tained 46 per cent. of silica at the time of the first sample, and thus was but slightly more basic than usual, yet the large addition of ore then made, 1 ton, had the double effect, first of lowering the temperature and thus favouring the removal of silicon, and then of making the slag effectively basic at the places where the actual oxidation is most rapid, *i.e.*, in the immediate neighbourhood of the individual lumps of ore; and it is the basicity in these parts of active oxidation that counts in determining the relative oxidation of carbon and silicon. Hence the large removal of silicon in spite of the low silicon content and high ratio of carbon to silicon.

But in case of the air-furnace operation which we here report, the high ratio of carbon to silicon, 3.5 : 1, is probably the condition which retarded the removal of silicon, because the low temperature should have favoured the removal of silicon, and the acidity of the slag is not great enough to explain the extreme slowness of the removal of silicon. That the temperature was very low at the beginning of the process is shown by the fact that the bath was but imperfectly molten, in spite of the fusibility implied by its having more than 3 per cent. of carbon. Neither the silica content of the slag, 46 to 62 per cent., nor its joint silica and alumina content, 50 to 67 per cent., is unusually great.

The presence of silicon favours graphitisation, *i.e.*, the change of the carbon from the combined to the graphitic state, certainly during solidification and probably in the annealing of the malleabilising process. As far as the annealing of the castings itself is concerned, therefore, the silicon content should be high, in order that, by favouring graphitisation, it may either shorten the time needed for the annealing, which, of course, consists essentially in graphitisation, or make the annealing more thorough. But the permissible silicon content is limited by the need of having the white cast iron itself free from initial graphite formed during and shortly after solidification (eutectic graphite), the coarse flakes of which would weaken the iron by breaking up its continuity. This initial graphite, of course, persists through the annealing; and, indeed, even if it could be removed by oxidation, the cavities where it existed would remain, and would weaken the mass about as much as if the graphite itself were still there.

Hence the practice of using much steel scrap in order (1) to reduce the initial carbon; (2) thereby to lessen the tendency to the formation of initial graphite, *i.e.*, graphitisation during and immediately after solidification; (3) thereby in turn to permit a greater silicon content without causing initial graphite to form; and (4) thus to shorten the annealing period or to make the annealing more complete.

Description of the Operation.

The charge consisted of: Steel scrap, 500; malleable cast-iron scrap, 500; hard metal or sprue, 7,200; pig-iron, 10,000; total, 18,200 lbs.

This was charged at 7.30 a.m., in an air-furnace of the usual type, a reverberatory furnace burning bituminous (Westmorland) coal on a common grate.

Sample 1, 10.18 a.m. The charge was not fully melted at the throat of the furnace, and the metal and slag were sluggish.

Sample 2, 10.33 a.m.

Sample 3, 10.58 a.m. Not yet all melted at throat. Rabbled the bath thoroughly before sampling. About 2 in. of thick sluggish slag on the bath.

Sample 4, 11.15 a.m. Nearly all melted. Did not rabble before taking this sample.

Sample 5, 11.31 a.m. Rabbled very thoroughly before sampling. The metal was a little mushy when poured into the test-mould. Immediately after this sample the whole of the slag was skimmed off. It was mushy.

Sample 6, 11.49 a.m. Taken immediately after rabbling. Was very fluid.

Sample 7, 12 m. Taken just after rabbling. This was the first of the "melter's samples."

Sample 8, 12.18 p.m. Stirred before sampling. No boiling in the furnace. The sample sparkled slightly. This was the last of the "melter's samples."

Sample 9, 12.31 p.m. Stirred thoroughly before sampling.

12.36 p.m. Began pouring. Metal sparkled much in ladles, but did not boil.

Sample 10, 12.47 p.m. Sparkling very much.

12.52 p.m. The iron had all run out.

"Hard metal" means the white cast iron as prepared in this air-furnace process, preparatory to its conversion into malleable cast iron by the graphitisation of its carbon in the annealing process.

Polishing Metals for Examination with the Microscope.*

By Albert Kingsbury.

In 1902 the writer made experiments to find the most suitable method of polishing samples of metals for microscopic examination.

At the outset, trials were made of all the methods of which descriptions have been published. Some of those methods have been successfully employed by various metallographists, as shown by numerous reproductions of excellent micro-photographs in different publications. Nevertheless the writer did not find any of these free from objectionable features. The ideal method should produce a fairly flat surface, free from excessive relief of the harder constituents, rounded edges at flaws, or scratches and smearing of the metal. The method should be simple, the materials employed readily available, and the process as rapid as is consistent with the first-named requisites. None of the published methods embodied all these requisites, nor is a perfect method likely to be found. However, the method finally developed by the writer appears to him superior.

The preliminary trials were made with rotating discs covered with various materials, including canvas, felt, silk, leather, chamois, parchment, paper, wood, pitch, asphalt, resin, shellac, beeswax, etc. The polishing powders included commercial abrasives, such as emery, carborundum, tripoli, crocus, and jewellers' rouge; also precipitates, such as carbonates and sulphates of the alkaline earths. Attempts were made to obtain fine finishing-powders by the levigation process from commercial abrasives. These abrasives were tried both wet and dry, and with various speeds of the discs. Hand-polishing was also tried. It is needless to detail the objectionable features encountered, which are probably familiar to all metallographists.

The method finally adopted was the result of two

* Paper read before the American Society of Mechanical Engineers.

distinct discoveries: (*a*) That ordinary paraffin wax makes a good polishing bed; (*b*) that excellent polishing-powders of certain grades are commercially available.

The paraffin is used as a facing for rotating discs of metal, preferably brass, about 8 in. in diameter. The discs are grooved on the flat face for anchoring the wax. To prepare the discs, they are warmed to about 100 degrees C. and laid flat, and the melted paraffin is poured on them to a depth of about ½ in., a removable ring or band retaining the melted wax. The whole is then covered to exclude the dust, and allowed to cool. After the wax has solidified it may be dipped in water to hasten the hardening. Since the wax has very little viscosity when melted, all hard foreign particles which might produce scratches in the samples settle out before the wax hardens, the elimination being practically complete. No advantage in this respect was gained by keeping the wax in a fluid condition on the disc for several hours in an oven. After the hardening of the wax, the discs are placed on the spindle of the polishing machine, and the faces of the wax are turned true and flat by a hand-tool.

In the writer's machine the spindle was horizontal, and four discs were used, for abrasives of progressive fineness, two discs being placed back to back at each end of the spindle. The disc used for the final polishing should not be perforated, and the wax should be continuous to the centre of the disc, as that part is best for the finishing touches to the sample. This latter disc should be at the right-hand end of the spindle. The speed of rotation should be about 200 revolutions per minute; a higher speed throws off the polishing-powder with the water used, and a lower speed makes the work too slow. A stationary sheet-metal strip about 3 in. wide bent over the discs serves as a screen.

The polishing-powders, in the order used, were as follows:—(*a*) Commercial flour of emery; (*b*) washed Naxos emery, 3/0 grade; (*c*) washed Naxos emery, 7/0 grade; (*d*) soft optical rouge, light grade. These were obtained from the George Zucker Company, New York, except the first, which is available everywhere.

The emery powders were mixed to a paste with water in tall glass jars provided with covers; the paste was applied to the rotating discs with small brushes as required, the brushes being kept in the jars when not in use. The rouge was in cake form, best applied by holding a small piece in the hand, wetting both the rouge and the wax, and pressing the rouge lightly against the rotating surface.

A small quantity of water is required throughout the polishing process, but water cannot be used very freely without wasting the powders. The water is best applied, as required, from a chemist's ordinary wash-bottle, held in the left hand while the right hand manipulates the sample. No water-pipes or drains are required for the polishing machine. Distilled water may be used if available. If tap-water is used, it should be drawn into large jars provided with covers and syphons, and allowed to stand a day or more before use, in order that all gritty particles in suspension may be deposited. The inner ends of the syphon tubes should be at least 3 in. above the bottom of the jars.

The treatment of the samples is as follows:—The samples are first dressed to shape and size by any convenient method, the surface to be polished made flat by an emery wheel or file, and the sharp edges rounded to prevent cutting into the wax. The dimensions of the samples should depend to some extent upon the coarseness of structure. For normal iron and steels, and for much other work, a ⅜ in. cube is a convenient sample. Massive castings sometimes have grains an inch or more in diameter, and correspondingly large samples are required. The samples are held flat against the waxed discs, which are kept well covered by the polishing-paste, using successively the flour of emery, the 3/0 emery, the 7/0 emery, and the rouge, on the several discs. At each grinding with emery the sample should be held without rotation, and with a slow transverse motion across the face of the disc until the grinding marks show over the entire surface. The sample may then be given a quarter-turn, so that the new marks cross the old ones, and so on. The discs must be kept wet continually while grinding. With each grade of powder the grinding should continue for some time after the marks of the last previous grade have disappeared, especially with soft metals, since the scratches cause a flow or disturbance of the metal to a minute depth below the surface, and if this disturbed metal is not ground off, the deep effect of the scratches becomes apparent on etching. In the final polishing on the rouge disc the samples should be continuously rotated; this is most readily done by moving the sample nearly in a circle about the centre of the disc in an opposite direction from the rotation of the disc. This keeps the direction of the grinding marks constantly changing, and avoids grooving. The finishing should be done near the centre of the disc, the slower motion being most effective for very fine polishing. After grinding with one grade of powder and before proceeding to the next, the samples and the operator's hands should be thoroughly washed; and the hands and the apparatus should be kept free of dust or dirt, to secure a polish free from scratches.

The most important item to be noted by the beginner is the liability of the paraffin wax to adhere to the samples when the grinding is begun, particularly in the case of the rouge disc. When the sample is first brought into contact with the disc, especially if the latter has been freshly prepared, the paraffin nearly always smears over the surface of the sample in a second or two, and if the sample is not removed and cleaned at once the result is a roughened disc, requiring re-turning with the hand-tool and reapplication of the paste. Therefore the sample should at first be touched very lightly to the disc, and at once removed and wiped with the finger, or with a cloth. If this is repeated several times the surface of the sample will no longer become coated with paraffin, but can be ground continuously, except when a fresh coating of paste is required by the disc. One great advantage of the paraffin disc over discs covered with cloth or felt, is that if the disc becomes roughened or cut, it can readily be turned smooth and true again.

For cleaning the samples after polishing, the best material is a stock of old linen or cotton cloth well-laundered and cut to 3-in. squares. These small pieces are preferable to larger ones, since they can be discarded for fresh ones after once using. The old cotton or linen is also the best material for cleaning the lenses and mirrors of the optical apparatus, being superior to chamois for this purpose.

The time required for polishing a sample varies somewhat with the hardness. A single sample of normal steel, cast iron, or wrought iron, may be finished in fifteen minutes; a set of five or six such samples may be finished in an hour. Hardened steels require a slightly longer time. The method has not thus far proved serviceable for very soft metals and alloys, particularly lead, owing to the persistent adhesion of the paraffin to the surface of the sample. The harder alloys polish well by this process. The finished surface presents a minute relief of the harder constituents, but much less than is produced by the use of felt or other very soft materials.

The Construction of Brass Furnaces.

By Walter J. May.

A good brass furnace for crucibles should give a great melting effect for the fuel used, should keep the heat as much as possible in the furnace, and should be effective for iron or even high carbon steel, should such have to be melted occasionally; but in any case cast irons should be easily dealt with at any time. With ordinary care such furnaces can be built at a cost very closely approximating to that required for those made to melt brass only, but a lot of crucible melting work is done at a cost which is, to say the least, immoderately high. The construction of steel furnaces proper is not now being considered, as these are out of the general run of foundry work, but still it may be necessary at times to deal with this metal, and for this reason any crucible furnaces attached to the ordinary foundry should be able to provide the necessary heat. To get heat you must have carbon and a good supply of oxygen in this class of furnace.

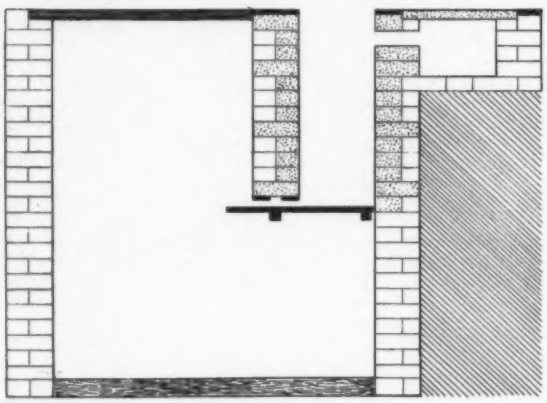


Fig. 1.

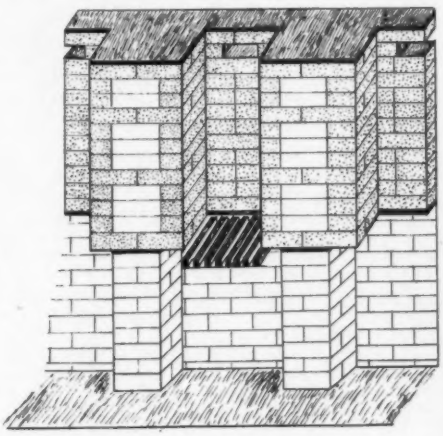


Fig. 2.

Brass Furnaces.

For the sake of safety in manipulation, all crucible furnaces should be put in so that the top of the furnace is level with the pit grating and floor, as at all times there is a chance of the crucible either breaking or slipping from the tongs, although, theoretically, such mishaps should not occur. Human fallability has, however, to be taken into consideration.

In every case a good draught is needed with the chimney, and with this it matters not whether each furnace has its own chimney, or whether one common flue exists for the whole range of furnaces; but with the view to using some of the heat which is unavoidably wasted, probably it is better to have a common flue leading to one chimney and to have this flue pass under a core oven and crucible store, both of which will be heated pretty freely if the floor is made over the flue and covered with iron plates, as this need not interfere with the draught through the furnaces. In all cases flues should be wide rather than deep, a flue 16 in. wide by 9 in. deep being more effective than one 12 in. each way, although each give the same cross area. The cover tiles necessarily cost more with the wide shallow flues, but the greater efficiency more than repays this extra cost in a short time. The area of the chimney should roughly be about one-sixth that of the total firebar area where a height of from 20 ft. to 25 ft. is adopted, but with this part of the work local conditions have often to be taken into consideration, and no hard and fast rules can be laid down. Personally, the writer prefers a chimney of circular section inside, because for equal areas there is a lesser wall surface, a chimney 13½ in. in diameter having an area of 143 square inches, and a wall circumference of 42½ in., while a 12 in. square chimney has a wall diameter of 48 in. and an area of 144 square in., and it has also angles which are likely to retard the upward movement of the air somewhat. Chimneys should be smooth inside to reduce friction as much as possible, and in cases where dampers are used they should be of such a size as to allow of the full-way of the chimney being unobstructed when the dampers are fully open. Usually it is desirable to save a space below the entrance of the flues into the chimney, and a soot-door should be put in, so that accumulations of dust can be removed when necessary; but soot is rarely made where hard coke is used as fuel. Comparative cross sections of round and square chimneys are shown in Fig. 4.

The furnaces themselves are, as a rule, simple in design, and, roughly, the section would be as shown in Fig. 1, the pit having a total width of about 6 ft. 6 in., and a depth of 6 ft. to get the best results. The object to be aimed at is to get the largest amount of air into the bottom of the furnace to ensure a sufficient supply of air to the fuel, and for this reason there should be brick columns, or if the expense can be incurred, cast-iron columns on which the brickwork of the furnaces can be carried. This gives the largest air space under the firebars where it is wanted most. The brickwork can very well be carried on 3 in. by ½ in. wrought-iron bars, and the bearers carrying the firebars should allow of an inch clear space between the top of the bars and the bottom of the furnace, or even 2 in. would not be excessive did the building arrangements allow this to be given with safety. The object is to permit as much air as possible reaching

the fuel, this being a necessary point if the highest stage of combustion is to be secured. As usually a fairly large amount of fuel per pound of metal melted is consumed, it is desirable to secure the maximum of heat from it, and while the writer considers that in practice hard coke gives the most economical results, it is still necessary that the combustion shall be carried on at a high stage, for, unlike gas coke, the

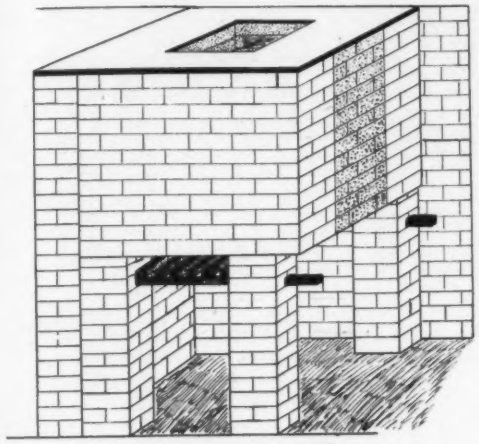


FIG. 3.—BRASS FURNACES.

hard furnace coke is durable, and so much is not required for melting a given weight of metal. As the coke has to be broken to the size of goose eggs the fire bar apertures have to be kept to moderate widths to prevent the coke falling through, and a 2-in. aperture is as much as can be safely allowed unless a large waste of fuel is to occur.

The pit should be excavated and walled round, and a strong floor put in before the furnaces are built, some efficient method of drainage being provided for if necessary, this being determined by the position of the place. The horizontal flues should then be put in, leaving a 9 in. by 3 in. aperture to communicate with each furnace, and then the "legs" to carry the furnaces should be put in, whether these be of 9 in. by 9 in. brickwork in cement, or iron columns of the right shape and height. The size of the run of furnaces required will determine the height of the legs, 100-lb. crucibles requiring a depth of about 35 in., and 200-lb. crucibles wanting a depth of 37 in., the clear squares of the furnaces being respectively 13 in. and 15 in. On the legs the bearing bars are placed and then the furnaces are built in 9-in. work, which may be wholly of firebrick, or of ordinary brick lined with firebrick, as shown in Fig. 2, the general outside appearance of the furnace being as shown in Fig. 3.

In some cases the front of the range of furnaces is tied in by an iron plate, such as used for annealing furnace work, but this is not usually necessary, although when used a different system of lining the furnaces can be adopted, fireclay slabs of a suitable size being used instead of bricks, thus leaving no joints to be attacked by the fire. This may possibly be advantageous. In ordinary brick furnaces the joints are the first to go.

It is a good plan to use iron plates over the tops of the furnaces, and these should be cast in the shape shown in Fig. 5, as this prevents cracking or buckling. Such plates should be well bedded in fireclay or soft mortar, and, of course, the grating over the pit and the plates should be level, for the reasons previously mentioned.

Some persons prefer circular furnaces for crucibles, and probably, where forced draught is used, these are more economic than square ones, but with natural draught the writer does not think they are as useful as square ones. Of course, with special tilting and other furnaces of a like character, where the draught is forced, and, in addition, can be closely regulated, an even layer of fuel outside the crucible will present many advantages; but unless the furnace is large in proportion to the crucible used these advantages do not occur in the ordinary working under natural draught, and round furnaces cannot be considered to offer any advantages. The same considerations do not apply with furnaces as with chimneys, and this is a point to be remembered.

All fire-work should be put together very carefully, the face of the work coming into contact with the fire being kept smooth, while the joints should be of the thinnest. The medium for bedding used should be well soaked fireclay used in soft condition, the bricks —previously soaked in water—being forced down close by rapping with a hammer or mallet, care, of course, being taken not to break them. Where ordinary bricks are used as part of the body of a furnace it will be necessary to get them down closely or they will not work in with the firebricks; in some cases this means that they will have to be cut thinner before they are laid, firebricks being 2½ in. thick and building bricks from 2½ in. to 3 in. thick, according to the makers. Even with the thin bricks the mortar must be made from sifted sand and used in a sloppy state to get the joints thin enough to work in with the firebricks.

The gratings over the pit should fit level and have sufficient bearers to keep them stiff while the crucibles are being shifted over them, but this point should scarcely need mentioning. It is a matter both of convenience and economy to have a girder of I-iron over

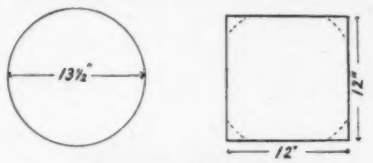


FIG. 4.—COMPARATIVE SECTIONS OF CHIMNEYS.

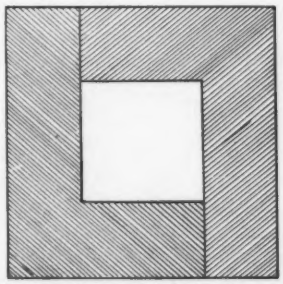


FIG. 5.—SHAPE OF IRON PLATES.

the centre of the range of furnaces on which to run a travelling hook to carry block tackle for lifting the crucibles, as one man can more readily lift a pot from the fire with blocks than two or three can by means of only the tongs and hooks. But two men are needed to carry crucibles about, and usually to pour the metal. The carrier should run freely along the girder, and chain tackle may be used if the chain is annealled from time to time; but if this is not possible rope should be used, a long shafted lifting hook for engaging with the eye in the tongs being used.

Analyses of Alloys.

TYPICAL AND SPECIAL ANALYSES OF FERRO AND OTHER ALLOYS.

We present herewith a series of analyses of alloys of iron and other metals which are of importance to the iron and steel industry. The analyses have been collected from various sources, and in order to indicate the authority from which we quote we append a table of references.

References :—
* W. Venator, in "Stahl und Eisen."
** Iron and Steel Institute Proceedings, 1903.
† E. Houghton; British Foundrymen's Association Proceedings.
‡ Iron Trade Review.

SPIEGELEISEN.

(Sold per Ton.)

The spiegeleisens contain less than 25 per cent. of manganese. The relative composition of English and German varieties of spiegeleisen are shown in the following tables:—

English Spiegeleisen.

Darwen & Mostyn Iron Co., Ltd.,
MOSTYN.†

	C.	Si.	S.	P.	Mn.
1	5.20	0.65	Nil.	0.090	29.75
2	4.89	0.95	,,	0.068	22.50
3	4.99	0.42	,,	0.074	20.11
4	4.65	0.48	,,	0.065	17.30
5	4.32	0.56	,,	0.063	14.40
6	3.94	0.45	,,	0.068	10.72
7	3.95	0.44	Trace	0.060	9.25

Guest, Keen, & Nettlefolds, Ltd.,
DOWLAIS.**

C.	Si.	S.	P.	Mn.	Fe.
4.50	0.95	—	0.05	20.00	74.50

Linthorpe Dinsdale Smelting Co., Ltd.,
MIDDLETON ST. GEORGE.**

	Per Cent.	Per Cent.	Per Cent.
Manganese	8.00	11.00	20.00
Iron	88.40	83.40	73.90
Carbon	3.00	5.10	5.20
Silicon	0.50	0.40	0.75
Sulphur	0.01	0.01	0.008
Phosphorus	0.09	0.05	0.09

German Spiegeleisen.*

C.	Si.	S.	P.	Mn.	Cu.
4.00	0.30	0.01	0.03	10.00	0.02
5.00	0.50	0.01	0.10	20.00	0.03

FERRO-MANGANESE.

(Sold per Ton.)

Ferro-manganese contains over 25 per cent. of manganese, below which it is classed as spiegeleisen. Standard ferro-manganese is guaranteed to average 80 per cent. or over manganese. The English runs lower in phosphorus than that from the Continent.

Typical Analyses.

	C.	Si.	S.	P.	Mn.	Cu.
Cleveland	7.00	0.50	—	0.20	76.00	—
German:—						
(Hordo)	5.31	2.52	Trace	0.30	55.06	0.17
(Phönix)	6.94	0.02	—	0.24	76.95	0.37
Russian	6.93	1.47	—	0.30	93.47	—

English Ferro-Manganese.

Darwen and Mostyn Iron Co., Ltd.,
MOSTYN.†

	C.	Si.	S.	P.	Mn.
1	6.31	0.53	Nil.	0.155	87.92
2	6.95	0.54	,,	0.146	84.33
3	7.00	0.30	,,	0.159	80.62
4	6.68	0.49	,,	0.199	70.55
5	6.28	0.63	,,	0.159	61.81
6	6.12	0.14	,,	0.112	50.60
7	5.02	0.10	,,	0.095	41.45

Guest, Keen & Nettlefolds, Ltd.,
DOWLAIS.**

	Ferro-manganese.
	Per Cent.
Manganese	80.00
Iron	12.30
Carbon	6.50
Silicon	0.95
Phosphorus	0.25
Sulphur	...

Linthorpe Dinsdale Smelting Co., Ltd.,
MIDDLETON ST.-GEORGE.**

	Per Cent.	Per Cent.	Per Cent.
Manganese	60.00	70.00	80.00
Iron	32.80	22.30	11.80
Carbon	6.40	6.80	7.20
Silicon	0.60	0.70	0.80
Sulphur	0.005	0.005	0.004
Phosphorus	0.100	0.140	0.180

METALLIC MANGANESE.

Geo. G. Blackwell, Son & Co., Ltd., (*Merchants*)
LIVERPOOL.†

C.	Mn.	Iron.
Under 5.00	95.00 to 98.00	2.0 to 4.0
Nil.	99.00	1.00

FERRO SILICON.

(Sold per ton.)

Typical Analysis of Low Grade Ferro-Silicon.*

C.	Si.	S.	P.	Mn.
1.10	17.06	0.019	0.13	1.23
1.19	15.28	0.015	0.11	1.30
1.61	13.10	0.016	0.11	1.12
1.96	10.30	0.020	0.07	1.90
2.36	10.55	0.030	0.04	3.86
0.90	17.00	0.040	0.08	1.59
1.21	13.45	0.020	0.058	1.71
1.40	12.42	0.025	0.054	1.17
1.35	11.50	0.030	0.038	1.35
1.51	10.37	0.028	0 060	1.86
1.55	9.25	0.038	0.035	1.84
1.75	8.10	0.045	0.056	2.20

Typical Electric Furnace Ferro Silicon.

*(Average Analyses.)**

C.	Si.	S.	P.	Mn.	Fe.	Cr.	Al.	Cu.	Ca.
0.52	25.89	0.030	0.040	0.41	72.92	—	—	—	—
—	29.66	0.010	0.300	0.56	72.99	0.25	0.30	—	—
0 07	25.80	0.005	0.136	0.23	68.59	—	1.14	—	—
0. 0	51.80	0.020	0.040	0.35	47.30	—	—	—	—
0.11	53 75	0.005	0.041	0.11	45.09	—	0.60	0.04	0.05
—	51.29	0.007	0.040	0.37	48.89	—	0.17	—	0.21
0.23	51.70	0.020	0.060	0.16	47.20	—	—	—	—
0.31	75.67	0.010	0.040	0.26	23.04	—	—	—	—

The silicon content varies, but the subordinate constituents remain constant within certain limits, the carbon content being generally low, though as much as 1 per cent. is sometimes found.

Makers' Analyses.

Darwen & Mostyn Iron Co., Ltd.,

MOSTYN.†

	C.	Si.	S.	P.	Mn.
1	0.90	17.00	0.04	0.080	1.50
2	1.21	13.45	0.02	0.058	1.71
3	1.40	12.42	0.025	0.054	1.17
4	1.50	11.50	0.030	0.058	1.35
5	1.51	10.37	0.028	0.060	1.86
6	1.55	9.25	0.038	0.055	1.86
7	1.75	8.10	0.045	0.056	2.20

Guest, Keen & Nettlefolds, Ltd.,

DOWLAIS.**

C.	Si.	S.	P.	Mn.	Fe.
1.50	12.00	0.04	0.09	2.50	83.87

Gjers, Mills & Co., Ltd.,

MIDDLESBROUGH.**

Brand—"Ayresome," Ferro-Silicon.

C.	Si.	S.	P.	Mn.	Fe.
1.40	10.00	0.02	0.05	2.50to3.00	83.77

George G. Blackwell, Sons & Co., Ltd,

LIVERPOOL.†

(Merchants).

C.	Si.	S.	P.	Mn.	Alum-inium.
0.27	32.70	0.04	0.05	0.31	0.13
0.09	48.70	0.03	0.04	0.13	0.17
0.00	75.80	0.02	0.02	0.11	0.08
0.00	94.80	0.02	0.01	0.08	0.10

FERRO-MANGANESE-SILICON, SILICO-SPIEGEL.

The compounds of iron with manganese and silicon may be regarded as compounds intermediate between ferro-manganese and ferro-silicon, and are produced in the blast furnace, and in the electric furnace.

Average Composition :—*

C.	Si.	P.	Mn.
1.39	14.23	0.098	20.87
1.51	13.31	0.095	20.39
1.05	12.52	0.065	17.50
1.89	11.80	0.081	18.90
1.26	10 33	0.071	20.32
1.45	9.45	0.070	20.50

The following is the composition of a silico-manganese compound produced from rhodonite (Mn. Si. O_3) in the Gin electric furnace* :—

C.	Si.	S.	P.	Mn.	Fe.	Al.	Loss.
0.16	25.02	0.01	0.01	68.64	4.40	0.74	1.02
0.18	25.51	—	—	69.26	3.18	0.60	1.27

Specific gravity, 6.5; fusing point, between 1,250 and 1,300° C.

Electric Furnace Silico-Spiegel.*

Composition of the chief grades:—

	C.	Si.	S.	P.	Mn.
1	1.0	20 to 25	0.03	0.06	50 t 55
2	0.8	20 to 25	0.02	0.052	68 t › 75
3	0.65	30 to 35	0.02	0.04	50 to 55

Makers' Analyses.

Darwen & Mostyn Iron Co., Ltd.,

MOSTYN.†

Silico-Spiegel.

	C.	Si.	S.	P.	Mn.
1	1.39	14.23	nil.	0.098	20.87
2	1.51	13.31	,,	0.095	20.39
3	1.05	12.52	,,	0.065	17.50
4	1.89	11.80	,,	0.081	18.90
5	1.26	10.33	,,	0.071	20.32
6	1.45	9.45	,,	0,070	20.50

Gjers, Mills & Co., Ltd.,

MIDDLESBROUGH.**

Brand—"Ayresome" Silico-Spiegel.

C.	Si.	S.	P.	Mn.	Fe.
1.50	10.00	0.02	0.06	18.0 to 20.0	66.93

Geo. G. Blackwell, Son & Co., Ltd.,

LIVERPOOL.†

(Merchants).

C.	Si.	S.	P.	Mn.
0.30	24.70	0.01	0.02	74.20
0.65	24.25	0.067	0.05	73.50
—	25.00	—	—	55.00
—	21.00	—	—	51.00
—	21.00		—	38.00

FERRO-PHOSPHORUS.

(Sold per ton.)

Ferro-phosphorus is sold per ton and contains over 10 per cent. P. The American is guaranteed:—P. 18 per cent. to 20 per cent.; S. under 0.05 per cent.; Mn. under 0.50 per cent. The European ferro-phosphorus is guaranteed up to 24 per cent. P.

Blast Furnace Ferro-Phosphorus.

*Typical Analyses.**

C.	Si.	S.	P.	Mn.	Fe.
1.14	1.46	—	17.23	0.76	79.40
1.20	1.80	—	25.56	0.64	70.65
0.30	0.50	0.160	20.50	3.00	—
0.31	0.50	0.325	17.85	2.80	—
0.273	0.84	0.160	15.71	5.90	—

Electric Ferro-Phosphorus.

*Typical Analyses.**

C.	Si.	S.	P.	Mn.
0.03	2.47	0.08	24.50	0.10
0.27	5.40	—	17.50	5.75

Makers' Analyses.

Darwen & Mostyn Iron Co., Ltd.,
MOSTYN.†

	C.	Si.	S.	P.	Mn.
1	0.300	0.500	0.160	20.50	2.00
2	0.310	0.500	0.325	17.85	2.80
3	0.273	0.840	0.160	15.71	5.90

Geo. G. Blackwell, Son & Co., Ltd.,
LIVERPOOL.†
(Merchants).

C.	Si.	S.	P.	Mn.
0.03	2.47	0.08	24.50	0.10
0.27	5.40	nil	17.50	5.75

FERRO-CHROME.

Chrome-Ore.

Chrome-ironstone is found in abundance in Asia Minor, New Caledonia, New South Wales, Canada, the United States, Hungary, &c. Ore suitable for ferro-chromium should be low in silica, and as rich as possible in chromium.

*Analyses by Steinhart:—**

Chrome Ironstone.

	Turkish. Per cent.	New Caledonian. Per cent.		Turkish. Per cent.	New Caledonian. Per cent.
Cr_2O_3	... 51.70	55.70	CaO	... 1.70	0.25
FeO	... 14.20	13.20	H_2O	... 0.3	1.05
Al_2O_3	... 14.1	16.2	MnO	... —	0.2
MgO	... 14.3	9.8	Pb_3O_4	... —	0.05

Chrome Ironstone from Oblisbo, California.

Cr	... 52.68	FeO	... 11.77
Al_2O_3	... 11.40	MnO	... 0.15
Fe_2O_3	... 3.52	SiO_2	... 3.40
MgO	... 16.23	H_2O	... 0.94

Ferro-Chrome.

(Sold per ton.)

Ferro-chrome usually contains 60 per cent. to 68 per cent. chromium. It is graded per unit of chromium and per unit of carbon, the price increasing with the chromium and decreasing with the increase in carbon, these elements being guaranteed.

Blast Furnace Ferro-Chrome.*

	C.	Si.	S.	P.	Mn.	Fe.	Cr.
1	8.60	0.60	0.05	0.05	0.40	44.90	45.10
2	9.10	0.50	0.05	0.05	0.30	30.00	60.00

Crucible Ferro-Chrome.

*Analyses by R. Busek.**

	C.C.	S.	Mn.	Cr.
1	—	—	—	36.22
2	3.80	—	0.33	19.80
3	5.40	0.30	—	67.15
4	—	—	—	48.70

Electric Furnace Ferro-Chrome.

The French works, according to Weil and Reinhardt,* furnish the following grades:—

	Carbon.	Chromium.
No. 1	7.5 to 9.0	60 to 70
No. 2	6.0 to 8.0	60 to 70
No. 3	4.0 to 6.0	60 to 70
No. 4	3.0 to 4.0	60 to 70

(Sold on the basis of 60 per cent. Chromium).

Refined Ferro-Chrome.

The rates for refined ferro-chrome depend more on the carbon content than on the percentage of chromium, the basis price being quoted for 60 per cent. of chromium. There are two chief grades:—

		Cr. Per cent.	C. Per cent.
Refined ferro-chromium,	No. 1. ...	60-70	0.30-0.75
,, ,,	No. 2. ...	60-70	1 -2

The refined ferro-chromiums are of fairly uniform composition. A special feature in all the following analyses is the low percentage of phosphorus, silicon, and sulphur:—

Analyses of Refined Ferro-Chrome. (*By Steinhart.**)

	C.	Si.	S.	P.	Cr.	Fe.	O.
1	0.555	0.115	0.009	0.031	62.452	36.702	0.141
2	1.271	0.115	0.009	0.013	68.174	29.863	0.205

Analyses of Refined Ferro-Chrome,
(*By Weil and Reinhardt.**)

	C.	Si.	S.	P.	Mn.	Cr.	Fe.	Al.
1	1.90	0.12	0.01	0.01	0.02	60.72	29.83	0.01
2	0.60	0.23	0.01	0.01	—	67.50	32.10	—

Analyses of Refined Ferro-Chrome. (*By Dujardin.**)

C.	Si.	S.	P.	Mn.	Cr.	Fe.	Al.
0.53	0.25	0.01	0.01	—	66.12	32.87	—

Makers' Analyses.

Darwen & Mostyn, Iron Co., Ltd., Mostyn.†

	C.	Si.	S.	P.	Mn.	Chromium
1	7.12	0.21	—	0.052	1.84	41.39
2	6.39	0 35	0.022	0.068	1.95	37.30
3	5.52	0.36	0.028	0.048	1 55	34.60
4	5.83	0.28	0 028	0.044	1.68	27.71
5	5.94	0.13	—	0.065	2.73	20.51
6	5.34	0.14	0.021	0.040	2.30	12.50

Geo. G. Blackwell, Sons & Co., Liverpool.† (*Merchants*).

	C.	Si.	S.	P.	Mn.	Chromium.
	8.80	1 35	0.045	0.053	Tr.	66.45
	7.00	1.20	0.035	0.050	0.150	65.35
	4.72	0 63	0.035	0.020	0.32	65.84
Refined	1.47	0.35	0.010	0.010	not given	69.30
Refined	0.65	0 14	0.028	0.010		63.59

FERRO-TUNGSTEN.

The chief deposits of tungsten ore are those of Queensland, New South Wales, Argentina, Brazil, China, the United States, Straits Settlements, Spain, Portugal, Wales, Bohemia, Saxony, etc. The Cornish tin mines also have recently been added to the list of deposits. Tungsten is found in the mines of the Clitters Company, East Pool, South Crofty, Drakewalls, etc.

The annual output of 60 per cent. to 70 per cent. tungsten ore is about 3,000 tons. The United States production increased from 46 tons in 1900 to 1,096 tons in 1906. Australia furnished 710 tons from Queensland, and 110 tons from New South Wales. For a period of 10 years the output from Portugal was small in quantity, but the production has largely increased; the chief mines are at Panasquiera in the province of Beira. The Spanish output, from the province of Cordova, has also been considerably increased. The English production in 1906 was 251 tons. Argentinian and Brazilian mines yield high-grade ore of excellent quality. Compared with the foregoing, the output of the German mines is small.

*Composition of the various ores:—**

	Spanish.	Australian	Bohemian (Zinnwald)	United States.
WO_3	61 13	61.23	71.76	63.20
SnO_2	0 68	0.57	—	—
MnO	6 42	1.31	16.30	1.10
FeO	10.88	16.71	7.60	20.36
SiO_2	7.71	3.21	1 69	15.00
Al_2O_3 ...	5.32	2.31	—	—
CaO	1.21	1.21	2 28	—
MgO	3.16	7.16	—	—
CuO	0.38	1.21	—	—
Co_3	—	2.05	—	—
P	—	—	—	trace
S	—	—	—	0.50

Analyses of Ferro-Tungsten.*

Ferro-tungsten, which is sold per lb. per unit of tungsten contained, has about the following composition:—

C.	Si.	S.	P.	Mn.	Wo.	Fe.	Al.	Ca.	Sn.	Ni.	Cr.
2.87	0.85	0.093	0.051	0.47	51.74	43.20	0.94	—	—	—	—
0.60 combined	0.06	0.080	0.003	—	85.79	13.50	—	—	—	—	—
3.30 combined	1.90	—	0.013	—	76.90	17.92		—	—	—	—
1.90	0.48	0.050	0.020	0.34	73.05	22.55		0.01	0.18	0.22	1.62
Average Analysis.											
1.75	0.33	0.010	0.01	0.80	72.50	23.39	0.06				

*Analyses of Ferro-Tungsten with varying percentage of Carbon.**

	C.	Si.	S.	P.	Mn.	Al.	Wo.	Sn.	Fe.
Soc. Electro-Metallurgique ...	1.56	0.33	0.01	0.007	0.43	0.09	64.70	trace	—
Low Carbon	0.38	0.13	0.07	0.009	—	—	87.40	trace	—
—	—	0.30	0.01	0.02	0.08	—	70.00 to 75.00	—	22.00
—	0.52	0.13	0.01	0.01	—	—	83.30	—	15.72

METALLIC TUNGSTEN.

Analyses of English Metallic Tungsten.

C.	Si.	Mn.	Mg.	Al.	Fe.	Wo.	O.
0.32	0.72	0.16	0.32	0.47	0.61	97.2	0.33
0.12	0.32	—	0.13	0.21	0.59	98.63	—

FERRO-MOLYBDENUM.

The raw materials are molybdenum glance, MoS_2, and Wulfenite, $PbMoO_4$. Although several deposits of molybdenum ores are known (Scandinavia, Japan, U.S.A., and Australia), the production is very small. The pure ore, generally separated by hand-picking, contains:—

	Mo.	S.	Fe.	SiO_2
1	60.00	39.00	0.75	0.40
2	59.50	39.00	0.90	0.40

Ferro-molybdenum is sold per pound of pure molybdenum contained, regardless of the percentage of other materials.

*Analyses of French Ferro-Molybdenums.**

(*Distinguished by high purity and low sulphur content.*)

	C.	Si.	S.	P.	Mo.	Fe.	Al.
Ordinary	1 87	0.17	0.030	0.030	52 50	—	Trace
Refined	0.34	0.09	0 010	0.009	52.00	—	—
High Grade (1)	2.27	0.11	0.020	0.007	84.80	—	—
,, (2)	3 24	—	0 021	0.028	79.15	17.52	—
,, (3)	3.27	—	0.020	0.027	83.80	12.72	—

*Analyses of Ferro-Molybdenum according to Steinhart.**

	C.	S.	Mo.	Fe.
High Carbon	6.30	—	87.50	6.40
Low Carbon	less than 2.00	0.05	75.80	difference

*Analyses of Ferro-Molybdenum by Weil and Reinhardt.**

C.	Si.	S.	P.	Mo.	Fe.	Cr.
3.00	—	—	—	80 to 82	16.00	0.60
0.30	0.12	0.03	0.01	80.00	15.40	0.73
3.08	0.12	0.05	0.01	75.53	20.40	0.73

METALLIC MOLYBDENUM.

Typical Analyses.

C.	Si.	Fe.	Mo.
4.40	0.32	0.53	93.58

FERRO-VANADIUM.

In the United States the New Vanadium Alloys Company has secured deposits on the San Miguel River, Colorado; and this Company also obtains Spanish vanadium ore of the following composition:—V_2O_5, 12.20 per cent.; Pb, 51.27 per cent.; SiO_2, 15.30 per cent.; Fe_2O_3, 10.14 per cent.; Al_2O_3, 3.15 per cent.; MnO, 2.29 per cent.; As_2O_5, 1.40 per cent.; P_2O_5, 1.10 per cent.; Cu ·, 0.5 per cent. Other deposits occur in Argentina, Mexico, and Sweden. The French ores at Albertville supply grades of ferro-vanadium with the following composition:—

*Analyses of French Ferro-Vanadium.**

C.	Si.	S.	P.	Mn.	Fe.	Va.	Cu.
1.07	0.09	0.009	—	0.07	—	47.50	0.01
1.04	0.09	0.025	0.020	—	45.84	52.80	—
1.42	0.12	0.030	0.009	—	64.22	34.10	—

Ferro-vanadium sold per pound at price per unit of vanadium contained.

Typical Analysis:—

C.	Si.	Mn.	Fe.	Va.	Al.
0.10	0.90	0.60	61.00	36.90	0.80

FERRO-TITANIUM.

The lower content ferro-titanium is sold guaranteed only in titanium (10 to 12 per cent.), and is sold by the pound of the alloy.

Typical Analyses of Low-grade Ferro-Titanium.‡

C.	Si.	S.	P.	Ti.	Fe. by diff.
0.67	0.37	0.03	0.01	11.21	87.68

If higher in titanium the alloy is sold per pound of titanium contained, regardless of other constituents.

Typical Analyses of High-grade Ferro-Titanium.‡

C.	S.	P.	Mn.	Ti.	Fe.	Arsenic	Al.
2.82	0.047	0.021	0.08	51.30	44.19	1.12	0.41

*Analyses of High-grade Ferro-Titanium produced in France.**

C.	Si.	S.	P.	Mg.	Ti.	Al.
3.20	1.21	0.03	0.02	0.29	52.00	0.31
0.47	0.87	0.02	0.03	0.19	56.17	0.25
3.28	1.21	0.03	0.02	—	53.06	0.30

NICKEL.

Nickel, as ordinarily used, contains over 99 per cent. nickel and is sold by the pound. The production and commerce of nickel are in the hands of the following companies, who also settle the price: (1) The International Nickel Company—also called the Nickel Trust; (2) La Societe le Nickel, Paris; (3) the Mond Nickel Company; (4) the Anglo-French Nickel Company, Swansea. The chief nickel ore deposits are those of New Caledonia and the Sudbury district (Canada), the minerals comprising garnierite and nickeliferous magnetic and copper pyrites. The proportion of nickel in the ores is low, being only from 3 to 7 per cent., the average being about 5 per cent. About 120,000 tons are mined yearly in New Caledonia, and about 240,000 tons in Canada, the latter yielding a mean output of 3.16 per cent. of nickel. The total annual production of ore throughout the world is about 400,000 tons. Unimportant deposits are also found in Germany and Norway, the Silesian ore containing 2½ per cent. of nickel; nickel is also obtained at the Mansfeld works as a by-product from the copper shale.

Analyses of Various Nickels.*

Le Nickel Company.

	C.	Si., Al.	S.	Cu.	Fe.	Co.	Ni. (little Co.)
Specially pure nickel	0.09	0.14	0.01	0.07	0.39	—	99.30
Average sample	0.14	0.54	0.02	0.08	0.49	1.20	97.30

Basse & Selve.

C.	Si.	S.	Ni.	Cu.	Fe.	Co.
Trace	0.19	0.05	97.87	0.10	0.45	1.45

Orford Company.

C.	Si.	S.	Ni., Co.	Cu.	Fe.	As.	Sb., Sn.
0.05	0.051	0.021	99.08	0.091	0.46	0.036	0.036

Mond Nickel.

C.	S.	Si. O_2	Ni.	Co.	Fe.
0.06	—	0.027	99.78	0.015	0.161

FERRO-NICKEL.

Ferro-nickel is supplied with 25, 35, 50, or 75 per cent. of nickel. The balance of analysis outside of the nickel and iron runs about:—

Carbon	0.85
Silicon	0.25
Sulphur	0.015
Phosphorus	0.025

Nickel alloys for special steels are being produced in the electric furnace by the Société Electrometallurgique de Froges and the Le Ferro-nickel Company. The following analysis of one similar alloy has been furnished by Weil and Reinhardt*:—

Ferro-nickel.

Ni.	50.00	Cu.	0.08
Fe.	48-49	Ca.	0.01
C.	0.61	S.	0.04
Mn.	0.28	Al.	0.01
Si.	0.10	As.	0.01
P.	0.04		

Ferro-Nickel Chrome.

*(Analyses by Weil & Reinhardt.)**

C.	Cr.	Ni.	F.	Various Elements.
0.25 to 0.75	51 to 52	17 to 19	29 to 30	0.10 to 0.20
1.30 to 1.80	50 to 51	17 to 19	28 to 29	0.10 to 0.20

MISCELLANEOUS ALLOYS.

Ferro-Nickel-Silicon.

Ni.	Si.	Al.	Mn.	Ca.	Mg.	P.	Cu.
30.00	47.20	2.90	0.90	0.15	0.57	0.02	2.58

Phosphor-Manganese.

Typical analysis of blast-furnace Phosphor-Manganese.

Si.	Mn.	P.	Carbon.	Iron.
1.00	65.00	25.00	2.00	7.00

Ferro-Calcium Silicide.

Ferro-Calcium Silicide for foundry use. Analysis supplied by Mr. G. Watson Gray, F.I.C., Liverpool.†

C.	Si.	S.	P.	Mn.	Fe.	Al.	Cal-cium.	Magne-sium.	Cop-per.
1.14	69.80	0.014	0.036	0.22	11.15	2.55	15.05	0.26	tr

Chromium-Molybdenum.

C.	Cr.	Mo.
0.50	30.0	50.0

Silicon-Chromium.

C.	Si.	Cr.	S.	P.	Mn.	Fe.	Mg.
3.49	17.17	50.20	0.01	0.027	0.70	28.29	0.24

Nickel-Tungsten.

C.	Wo.	Ni.	Si.
0.5 to 1.0	50.0 to 75.0	25.0 to 50.0	0.25 to 0.50

Nickel-Molybdenum.

C.	Mo.	N.	Si.
0.5 to 1.0	50.0 to 70.0	30.0 to 50.0	0.25 to 0.50

Nickel-Chromium.

C.	Cr.	Ni.	Si.
1.00	72 to 75	24.00	0.25

Ferro-Boron.

C.	Bo.	S.	P.
2.855	32.10	0.03	0.005

Silicon-Aluminium-Manganese.

Approximate Analysis—supplied by Geo. G. Blackwell, Sons, & Co., Ltd., Liverpool.

C.	Si.	Mn.	Al.	Iron.
0.20 to 0.30	25.00	58.00	15 00	2.00

Ferro-Aluminium.

Supplied with aluminium content 5 per cent., 10 per cent. and 20 per cent.

Ferro-Aluminium Silicide.

Analysis supplied by Mr. G. Watson Gray, F.I.C., Liverpool.†

Iron.	C.	Si.	S.	P.	Mn.	Al.	Calcium.	Magnesium.	Copper
44.15	6.55	45.65	0.010	0.027	tr.	9.45	nil	nil	tr.

Carbide of Silicon.

Average Analyses.

Comb. C.	Free C.	Si.	Fe.	Al.
28.00	7.00	62.00	1.00	1.50

Carborundum (Silicon-carbide).

The American output supplies the bulk of the trade. Carborundum chiefly consists of silicon-carbide (SiC), with only small quantities of iron and alumina, as shown in the following analyses*:—

	1. Per cent.		2. Per cent.
Si	69.19	Si	62
C	29 71	C	35
Al_2O_3 } ...	0.39	Al	1.5
Fe_2O_3 }			
CaO	0.19	Fe	1.5
MgO... ...	0 06		
O	0.47		

Ferro Sodium.

Ferro-sodium is usually sold with 25 per cent. metallic sodium, and free from lime or excess of carbon.

Experiments at the Domnarfvet Works (Sweden) with the Production of Pig-Iron by Means of Electricity.*

By Director Yngstrom.

For some considerable time experiments have been made at the Domnarfvet Ironworks with the object of producing pig-iron directly from iron ore in electric furnaces. These experiments have not yet been concluded, for which reason it has not been considered advisable to give a detailed report at the present moment. However, as the results, no doubt, would be of great importance to ironmasters and others, the author has obtained the permission of his co-partners to give a short report of the results arrived at.

In 1906 the A.-B. Electrometal and the Grängesberg and the Bergslaget Iron Mines entered into an agreement for the purpose of making experiments in producing iron by means of an electric furnace invented and constructed by three engineers—Messrs. Gronwall, Lindblad, and Staalhane. This furnace was originally built according to the induction principle, but has been modified from time to time, and has already been described in these columns as it is being used at present.† It is sufficient to add that the hearth of the furnace is cylindrical, *i.e.*, the lower part of it, which is covered by an arch. The electric current, three-phase alternating, is conducted to the furnace through electrodes of carbon, passing to the cylinder-shaped part of the furnace through the aforesaid arch, which is cooled by means of water. The pressure during the experiments has been about 40 volts, with about 8,000 to 9,500 amperes, and the load 480 to 500 kilowatts. In order to protect the arch of the furnace against the high temperatures, furnace gas, which is obtained from the upper part of the furnace, is brought down under the arch through three openings by which a cooling effect is obtained. This arrangement has proved to be of great service and practical advantage.

The furnace is started and worked in the same way as an ordinary blast furnace. The charge used at present is of a weight of about 2 cwts. of ore from the Grängesberg Iron Mines (containing about 60 per cent. of iron), 7 lbs. of slaked lime, and 40 lbs. of coke. According to an estimate made, this is equal to a consumption of 5 cwts. 3 qrs. of coke per ton of pig-iron. The coke which was utilised contains 81 per cent. of carbon, 7 per cent. of water, and 11 per cent. of ash.

In a previous case an experiment was made with a charge, containing 2 cwts. of ore, 39 lbs. of coke, and 4 lbs. of lime, which is equal to about 5 cwts. 2 qrs. of coke per ton of pig-iron.

With regard to the products obtained in the furnace, the content of carbon has in certain cases been reduced to a figure as low as that of steel. As a rule, however, pig-iron only has been produced. Time and experience will prove which of these products may be of the greatest advantage.

In the experiments which are now going on the content of carbon has generally averaged about 1.80 per cent., while it has previously been about 3.20 per cent. The content of silicon has been varying, as a rule, from 0.2 to 0.07 per cent., but it has also been higher, and in one particular case it was even as high as 4.40 per cent. The content of sulphur in grey pig-iron has been reduced to 0.005 per cent., and even below this figure, while the content of sulphur in the coke utilised was about 0.5 per cent.

The supply of electric power is, however, of the greatest importance in the production of pig-iron directly from ore by means of electricity. As regards such power in its relation to the industry and its capacity in the manufacture, no definite result has been arrived at; the average in the most favourable cases has been something above 2 tons per electric horse-power-year. But there is every indication in favour of the supposition that, provided the supply of power to the furnace were to be increased, its thermal effect would also improve to such an extent that 3 tons per electric horse-power-year ought to be obtained. According to a theoretical estimate made, the production should exceed even this figure, which is not at all improbable in view of the fact that 3 tons per electric horse-power-year has been obtained by experiments made elsewhere.

* Communicated to the "Jernkontor."
† See FOUNDRY TRADE JOURNAL, May, 1909.

The Casting of Brass.

By A. Napier.

It is a curious fact that many manufacturers and users of metals apply the terms brass and bronze indiscriminately when referring to either of these alloys, despite the fact that there are essential differences in their compositions. Bronze consists mainly of copper and tin, while brass is essentially an alloy of copper and zinc. This difference is important, as the nature of the contents has a great effect on the properties of the resulting alloys. Although the chief metals used in the manufacture of brass and bronze are those mentioned, small quantities of other materials also enter into the composition. This point will be referred to later.

History of Brass and Bronze.

Bronze is, perhaps, one of the oldest of the commercial alloys, as far back as 3700 B.C. being stated as the date of certain samples discovered. Other specimens have been identified with Troy, while other relics again have been found in Egypt, Assyria, Babylonia and other countries. The majority of the earliest bronzes were composed almost entirely of copper and tin, but about the period of 450 B.C. lead appears to have been introduced into bronzes by the Romans. Zinc also is found in some early bronzes, an Etruscan bronze containing 0.73 per cent., while in early Japanese bronze, also, zinc appears as well as lead. The introduction of both these metals probably occurred in the first place by accident, though there can be no doubt that eventually they were intentionally used to obtain certain properties in the bronze. Brass does not appear to have been in use at such an early date as bronze, but its origin was certainly very early. As in the case of bronze, the addition of zinc to copper which produced brass was probably first the result of zinc ores being accidentally introduced into the furnace with the copper ore, but eventually calamine was regularly employed to produce brass. Ecclesiastical brasses or lattens which exist in some of our churches form a means of tracing the history of the alloy, which, until the middle of the sixteenth century was manufactured in Flanders and Germany and imported into England. Considerable quantities of lead and tin were included in the composition of those alloys.

The manufacture of brass in England began about the middle of the sixteenth century, but the alloys produced are stated to be somewhat inferior in wearing qualities to the earlier imported ones. It is stated by Hains that in 1565 a patent was granted to William Humfrey, assay master of the Mint, and Christopher Shutz, to search and mine for calamine, and to have the use of it for making all sorts of battery wares, cast works, and wire lattens. The year 1700 saw the brass industry firmly established in this country, from which date it has continued to flourish.

Methods of Making Brass.

The early method of making brass with calamine consisted in heating a mixture of zinc oxide, charcoal or coal dust and granulated copper in crucibles. The zinc oxide was reduced by the charcoal, and the liberated metal then alloyed with the copper. The direct fusion of the metals has, however, long since superseded the early method. At present the copper is first melted under a layer of charcoal to prevent oxidation, and the zinc is added to the molten metal at as low a temperature as possible, the whole being then stirred, and after being allowed to cool somewhat is poured. Plumbago crucibles are usually used for this work, though for certain work, where large quantities of low brass are required, the alloy is sometimes made in a reverberatory furnace. The former method, however, secures the smallest loss of zinc in the course of melting, and as this is an important feature, if the ultimate content of zinc is to be calculated, the crucible process is generally regarded as the best. There are other points also which support this view. The crucible furnace may be heated by coke, gas or oil, each of these fuels having its own features and characteristics. Good results can be obtained from either fuel if handled properly. The copper should be kept well covered with charcoal to avoid oxidation, and should also be brought to a sufficient heat to properly take the zinc when that is added; otherwise, chilling will result, and the zinc will be liable to melt and lie on top of the copper without mixing properly; then, as the whole becomes heated up, volatilisation of the zinc will occur. The proper temperature at which to add the zinc is indicated by a hissing noise being produced as the zinc is introduced. Thorough stirring of the mixture also is very important, as the spelter, being lighter, tends to float on the top of the copper. A club-shaped stirrer is recommended as being the most effective. The crucible should be allowed to remain in the fire a short time after the metal has been stirred, as this allows the oxide of zinc, formed by the reaction between the spelter and the copper, to come to the surface. A dirty brass is liable to result from too hasty a removal of the metal from the crucible. The pouring temperature is a very important point, for if this is high blow holes will probably result, and if the pouring temperature is too low imperfect cohesion of the metal may occur.

Classification of Brasses.

The range and composition of brasses is very considerable. The percentage of the different constituents varies greatly according to the use to which the metal has to be put. Commercial brasses range from about 95 per cent. copper and 5 per cent. zinc to 40 per cent. copper and 60 per cent. zinc, small quantities of other metals being, of course, included in these amounts. Those alloys containing from 50 to 70 per cent. copper are, however, the most useful. A division of brasses into distinct classes is difficult, but a convenient classification is as follows:—(A) High brasses for cold rolling; (B) low brasses for hot rolling; and (C) cast brasses. The first are usually composed of more than 60 per cent. copper, and are very suitable for drawing and rolling. The alloys of the second-class are suitable for hot rolling, and usually contain from 55 to 63 per cent. of copper. The brasses for casting, which are the ones we are more concerned with, are very variable in composition, and according to the use to which they have to be put may contain more or less considerable proportions of impurities. The copper content usually ranges from about 50 to 70 per cent., about 70 per cent. and 30 per cent. of zinc being standard English brass. This latter, in addition to casting well, can also be hammered and rolled.

The use of brass for casting necessarily results in a good deal of scrap being employed, and as the remelting of the metals is accompanied by various losses of different constituents, considerable variations are often experienced in the actual composition of the finished castings. Then again, there are a number of mixtures which are commonly classed as

brasses, which contain appreciable amounts of tin and other metals. As an example may be mentioned a brass-valve mixture used in one American foundry, viz. :—Copper, 76.60 per cent.; tin, 4.08 per cent.; zinc, 5.74 per cent.; lead, 13.16 per cent.; and iron, 0.42 per cent. Then again, there are a number of special brasses containing percentages of such metals as aluminium and manganese. Aluminium-brass is an alloy which contains up to about 4 per cent. of aluminium and gives excellent castings. It can also be forged and rolled while hot, and is suitable for casting pumps, valves, propellors, etc. According to tests made by Guillet, with a brass consisting of about 70 per cent. copper and about 29 per cent. zinc, as the percentage of aluminium increases up to 5 per cent. the tensile strength greatly increases, though as 5 per cent. is approached the elongation drops considerably.

Manganese-bronze, so called, may really be considered as another of the special brasses, as the composition differs very slightly from ordinary brass. A copper-tin alloy containing manganese is not often met with. The alloys sold commercially as manganese-bronzes are usually either alloys of copper and zinc containing up to 6 per cent. of manganese, or alloys of copper and zinc to which ferro-manganese has been added. Aluminium and tin are sometimes found in these latter alloys, but really they are essentially brasses. It is curious that many of these manganese-bronzes, or manganese-brasses as they should preferably be called, contain little and sometimes no manganese. This is probably explained by the manganese acting as a deoxidiser and thus being absorbed and carried away. In such cases the iron with which it was associated is left behind in the alloy, and has a considerable influence on the latter's properties. Cast manganese-bronze is made in several varieties, and as it is exceedingly tough is used for marine engine parts, valves, cylinders, etc., and also for propellers, this being a very important application of the alloy.

When ordinary brass contains as little as 60 per cent. of copper it cannot be worked cold, though it is still malleable at red heat. Alloys with a composition ranging about 60 per cent. copper and 40 per cent. zinc are often termed yellow metal, or Muntz metal. The latter is on account of the fact that in 1832 Mr. G. F. Muntz patented an alloy of 60 per cent. copper and 40 per cent. zinc, and the name should readily be restricted to alloys of this composition. The term "yellow brass" is also applied to brasses with copper as low as 48 per cent. Such metal has a fine yellow colour and has a considerable application for castings, though it is very brittle at red heat. The alloys containing less than 46 per cent. of copper are known as white brasses, and are used chiefly for brazing purposes. There is one other class of brass that is perhaps worth mentioning, viz., that containing less than 34 per cent. of copper. This is brittle and weak, and is principally used for casting such work as statuettes, etc. It is then bronzed by electro-deposition or other means, and sold as French bronze. Its principal qualifications are that it can be made more cheaply and that it can be cast at a lower temperature than better class alloys, on account of its low content of copper.

Influence of Constituents and Impurities.

Theoretically, brass should contain only copper and zinc, but in very few commercial brasses, particularly those used for castings, does this apply. In many cases other metals are intentionally used in order to obtain certain characteristics. Among the constituents other than copper and zinc that are frequently found in brasses may be mentioned lead, iron, arsenic, aluminium, antimony, bismuth, manganese, nickel, and tin. Though these elements are often only present in minute quantities, even in small proportions they have very definite effects on the alloy. The writer proposes, therefore, to consider the impurities in brass individually, noting the effect of each.

Lead.—It might be said that modern commercial brass is never entirely free from lead, as a small percentage of this metal is invariably contained in the zinc used in brass manufacture. About 0.10 per cent. lead is the maximum allowable in high-class brass, as it tends to reduce the ductility of the alloy. The amount of lead which brass will take up is small, and any excess tends to separate out in cooling. If 5 per cent. or more of lead is present in a brass that is being worked, it will often squeeze out during working, showing it to be quite a separate constituent. But with much less than this amount the microscope detects it as having separated out in films and globules between the crystals of brass. This being the case an appreciable quantity of lead is not permissible unless strength is of secondary importance; but as much of the brass used for castings has to be turned, and is not used for work requiring the maximum of tensile strength, the addition of a certain proportion of lead is advantageous. Pure brass is difficult to turn owing to its toughness; lead, if present, breaks the continuity of the structure, and as it is a weak metal the turnings break up into short chips as they are produced, and leave the tool easily. The amount of lead added to brass to obtain a suitable metal for turning is usually about 2 to 3 per cent., but this is subject to considerable variation where other metals also enter into the composition of the brass. It is also stated by some authorities that lead acts as a lubricant, thus allowing higher speeds in working. It is usually added to the crucible after the zinc, while the crucible is still on the fire, though it can also be added after the crucible has been taken out, as a high temperature is not necessary—in fact, is very undesirable—on account of the low melting point of lead.

Antimony.—This may be regarded as an accidental constitutent of brass, for it is never added intentionally, but is usually contained in copper as an impurity. Antimony is a distinctly undesirable constituent of brass, as it hardens the alloy and destroys its ductility, rendering it brittle and liable to cracking. As little as 0.01 per cent. of antimony will render brass useless for cold drawing and similar work, though for castings this amount may often pass without creating appreciable trouble.

Arsenic.—This element has a similar effect to antimony, though not to such a marked degree, and is regarded as an objectionable constituent in good brass for drawing. For castings, however, it has some good features, as it gives fluidity to the metal and thus enables it to cast well. According to the conclusion of Sperry, 0.02 per cent. arsenic imparts ductility to brass, probably by a reduction of the oxide of copper formed during melting. Opinions differ somewhat in regard to the possible utility of arsenic in brass, some authorities contending that 0.05 per cent. is the maximum when the metal has to be rolled. In any case, more than about 0.02 is not to be recommended for good work.

Iron.—Formerly iron was probably only present in brass as an accidental impurity, and while many users now regard it as an objectionable constituent it has its advantages in small quantities. Iron is often added intentionally in order to obtain a strong and hard alloy, while sterro-metal and Aich's metal contain from 1.5 to 2 per cent. of iron. Delta metal, patented by Alexander Dick in 1883, contained from 1 to 2 per cent. of iron, this metal being

introduced in the form of an alloy of iron and zinc. A small percentage of phosphorus also was added to prevent oxidation. At the present time, however, Delta metal frequently contains manganese, aluminium, and tin, the average analysis being about 55 per cent. of copper, 42 per cent. zinc, 1 to 2 per cent. iron, and small quantities of the other metals mentioned. The resulting metal is stronger than ordinary brass, and of a brass-yellow colour. It is also said to resist corrosion better than ordinary brass. Durana metal, another iron brass, resembles Delta metal, and is manufactured in Germany. When present in small quantities iron appears to exist in the alloy as a solid solution, and does not form chemical compounds; with more than 2 per cent. of iron, a compound of iron and zinc is formed. This probably accounts for a small percentage increasing the ductility of the alloy, while larger quantities are objectionable. Particularly in scrap which is being remelted is iron undesirable, for in such cases it is likely to separate out in the form of extremely hard nodules or spots, and this is very bad for castings that have to be machined. These nodules being extremely hard often will resist the cutting tool and make good work impossible.

Sulphur.—This is a very objectionable impurity in brass when it does occur, but is very seldom present in new metal. It may occur as the result of bad melting conditions, such as where a sulphurous fuel is used in a reverberatory furnace. But though not present in new brass sulphur may be found in remelted metal, as the result of using dirty scrap. Sulphur in brass to be cast produces dirty castings.

Bismuth.—A small percentage of bismuth does not appear to be greatly harmful to brass, though 0.2 per cent. is quoted by one authority as the maximum if the brass has to be rolled. Its effect is to cause brittleness by forming a thin film between the crystals of brass, as it is not appreciably soluble in the copper-zinc alloys. This characteristic renders bismuth very objectionable for many classes of work, but, fortunately, it is rarely present in any quantity.

Aluminium.—Except in remelted brass, aluminium is not likely to be present accidentally. It is, however, often added to produce special alloys, such as the aluminium-brass previously mentioned. But while it casts well and gives a good alloy when present in quantities up to 4 per cent., in some classes of work the aluminium is considered to be objectionable, and as the increasing use of aluminium becomes apparent in scrap metals, it often gives trouble to the foundryman. Many of the objections that have been raised against aluminium in brass by some founders are, however, probably the result of not knowing how to treat the metal. It must be admitted though, that when aluminium is contained in a brass mixture, oxide of aluminium is very liable to form on the surface of the metal. But despite its drawbacks the use of aluminium has a number of good features that recommend it, especially in work where tensile strength is of importance. When aluminium-brass is used for castings they should be allowed to cool slowly.

Manganese.—As already remarked, manganese is used in brass mixtures to produce what is known as manganese-bronze. It acts chiefly as a deoxidiser, and as such is often entirely absorbed. Accordingly it is difficult to really estimate the effect of manganese, and especially as it is generally introduced as ferro-manganese, when the effect of the iron which is left in the metal has to be considered. But manganese is generally considered to strengthen and harden the alloy, and diminish the extension before fracture. Comparatively pure manganese is now, however, finding favour as a deoxidiser, and an excess does not appear to be detrimental. Owing to its high melting power the manganese is introduced in the form of a copper-manganese alloy.

Tin.—This metal is often added in brass mixtures, both for the drawing and casting. The effect is to harden the alloy, and when present in quantities up to about 2 per cent. is often an advantage. But as an appreciably greater amount increases the hardness and brittleness, it is questionable whether the amounts used in many mixtures are really advantageous. Certain valve-makers reckon to use as much as 5 per cent. of tin, the lead content also being kept fairly high, and good results are obtained. As iron also enters into the composition of such brass, the combined effect of the constituents must be considered, and it is as well not to pronounce tin in large quantities as desirable, without careful consideration being given to the purpose to which the alloy has to be put.

The use of complex alloys is becoming more general, but though a number of good mixtures are thus obtained, it is the writer's opinion that simpler mixtures would often give equally good, if not better, results, if they were properly understood. Having now considered the effect of the various constituents of brass, the question of moulding for castings and casting the metal may be dealt with. But before coming to the melting of brass we will consider some of the fluxes that are used in the melting of metals.

Fluxes.

Not infrequently the term "flux" is applied alike to non-metallic substances, such as borax, fluor-spar, etc., which melt and form a fluid slag on the metal, and metallic substances which are introduced to act as deoxidisers. The former is, strictly speaking, the only proper class to which the term should be applied. The purpose of a flux is either to protect the surface of the molten metal from the effects of the atmosphere or to dissolve the oxides which form when the metal is melted. Ingots of metal and good-sized pieces of clean metal or alloy can be melted without the use of a flux, only some protection being given to the surface of the metal to prevent it oxidising by contact with the atmosphere or the products of combustion. But in many cases a flux is a necessity if a good, clean metal is to be got. The use of fluxes is, however, accompanied by a number of difficulties, and it is necessary to consider all the points of the case when choosing what flux to use for a special purpose. Fluor-spar, for instance, readily dissolves clay, and therefore the use of this in a crucible involves the disadvantage that the flux will attack the clay that is mixed with the plumbago and destroy the crucible after a comparatively small number of heats. Fluxes are necessary when the material to be melted is dirty, such as grindings or washings, as the impurities cannot otherwise be separated from the metal. Owing to the effect of fluxes on the crucibles there is a good deal of prejudice against their use; but if the metal to be melted is at all dirty, a much better result will be got by the use of a flux. The choice of which one to use must depend on the work and on other conditions, but the features of some available fluxes will be of interest.

Sal-Ammoniac is a very suitable flux for melting zinc. It reacts on the oxide of zinc and produces chloride of zinc, which melts on the surface of the metal, and ammonia gas, this latter being driven off. This flux has been recommended and tried at various times for use in melting brass, but it does not appear to be satisfactory for alloys or metals with high melting points, such as brass and copper.

Borax is a very popular fluxing material, although an expensive one. It acts well in the absence of silicious material, as it dissolves the metallic oxides.

As it has no effect on silica and silicious materials it is not suitable for use as a flux when these are present. Also, it must be remembered that in addition to its initial cost crystal borax contains nearly 50 per cent. of water, which, of course, is driven off on heating; this practically doubles the cost of the flux.

Plaster of Paris.—This is perhaps one of the most popular fluxes with the brass-founder; it has the property of dissolving oxides and silica, and finds extensive application for brass-foundry work. It melts at a red heat, and though it does not become so fluid as fluor-spar it pours out quite readily. There is one objection, however, to the use of plaster of Paris for good brass work; it gives off sulphur when in contact with coal or coke. But for melting chips, washings, and grindings containing iron this feature is an advantage, as the sulphur acts on the iron, forming a matte and removing it from the metal. Plaster of Paris also does not act on the crucible.

Cyanide of Potash.—This is a very good flux, as it reduces the oxides of many metals, such as copper, tin, and lead. It melts to a clear fluid, but attacks the crucible strongly, and is in addition very poisonous and expensive. The poisonous properties of the flux are, however, not manifest when it is melted, for it decomposes before it volatilises. Despite its several drawbacks it is considered by many people to be the best of fluxes.

Li-Carbonate of Soda and Soda Ash.—These substances readily dissolve sand, clay, and silicious materials, and consequently attack the crucible as well as such impurities in the metal. They are not so effective as regards the oxides, and are not usually recommended for use alone, though they make a good flux when mixed with sand.

Glass is an old flux, and is usually powdered and placed in the bottom of the crucible. It forms a good protective covering for the metal, but does not act upon the impurities in the metal. Although it has been used to a great extent in the past it has given place to more effective fluxes.

Salt.—Perhaps one of the most useful of fluxes is common salt. It is largely used for melting brass that has to be rolled, as it decomposes oxide of copper, and thus prevents this being absorbed by the metal. All copper alloys are improved by the use of salt, and it may be used freely. A double handful may be added when the metal goes into the fire and more after it begins to melt. Enough salt should be added to create a little slag on the metal, which is easily skimmed off.

Fluor-Spar.—This is one of the best fluxes for general use. It dissolves the oxides in the metal and also any silicious material present. Accordingly it is very suitable for melting down washings, grindings, etc. As it melts to a clear limped fluid when used alone, and in the absence of a large amount of impurities to be slagged off, its effect on the crucible is bad. The best way in such cases is to mix it with lime. This produces a slag which is readily skimmed off. The amount of lime may be increased or decreased to give a more or less fluid slag, and the lime, too, tends to remove any sulphur from the metal. Seventy-five pounds of lime and 25 lbs. of fluor-spar give a very useful flux, the slag produced being thick enough to allow of its being readily skimmed off.

Charcoal is well known as a protective covering for brass melting, and has already been referred to in connection with this work. In addition to the foregoing there are a number of other materials that may be used as fluxes, but on account of various features which render them more or less undesirable, they have not been mentioned here. Salt is perhaps the best one for general brass work, lime and fluor-spar being best for brass washings. There are, of course, a number of patent fluxes on the market, all with some good features, but they have also been omitted in the foregoing list.

(To be continued.)

Some Points in the Production of Steel Castings.

The Electric Furnace.

The possibilities of the electric furnace in steel foundries were dealt with in the course of a discussion at a recent meeting of the mechanical section of the Engineers' Society of Western Pennsylvania. Referring to what the electric furnace has done in making it possible to produce intricate shapes and very thin-walled steel castings, Mr. J. S. Unger, manager of the research laboratory of the Carnegie Steel Company, said:—

"I saw a steel casting recently which was a fork for a bicycle, 6 in. long, with walls not over ⅛ in. thick at any point, cast from steel made in an electric furnace. We had the specimen sawed longitudinally and it did not show a single cavity. It was absolutely as sound as though forged or drawn from a piece of tubing. I do not believe that a casting with walls as thin as that could be made in an ordinary steel furnace. It is possible to raise the temperature of the steel in an electric furnace to such a high point that it will flow in as thin a wall as that, while the reducing action of the electric furnace prevents many of the gases from being occluded. There is not any bubbling or motion at all while the casting is being poured. . . . When it is considered that the temperature of an open-hearth furnace is not over 150 degrees above the melting point of steel, it is realisable that the steel foundryman's means are limited. The steel is being made under oxidising conditions and absorbs and holds large amounts of gases in solution, giving up a portion of these on cooling, producing sponginess. If he could raise the temperature of that steel by means of the electric furnace to almost 1,000 degrees above the melting point and make the steel under reducing conditions, he could make sound castings that under ordinary conditions he cannot secure. Say the melting point of steel is 1,600 degrees, a good open-hearth furnace will be about 1,750 degrees, while an electric furnace will work at 2,600 degrees."

Heat Treatment.

On the question of heat treatment Mr. Unger commented as follows:—

"I know that the price at which we buy ordinary steel castings to-day will not justify a treatment that

is at all complicated or that will cost much money. However, one is almost compelled to use steel castings in some cases, owing to difficulties in preparing a forging of the design suitable for the purpose. At the present time in some classes of work, such as automobiles, special castings of alloys are being made which contain such metals as nickel, chromium, vanadium, titanium, and quite a number of other metals alloyed with the ordinary constituents of steel. Some of these alloys have given very excellent results.

"One finds that when using a special alloy of any kind, in order to get the best results and develop the best qualities in the steel, it is necessary not simply to anneal it, but to give it treatment more or less complicated, depending on the results required. Ordinarily treatment by heating the casting to the proper temperature, then plunging it into oil and chilling it, afterwards reducing the hardness produced by the oil, is sufficient. There are special alloy castings in which ordinary treatment in oil is not sufficient, but water must be used to obtain the results, the oil not being sufficient to break up the coarse grain or structure. It is possible by treatment to make these special castings the equivalent of a forging. The effect of treatment is especially noticeable in manganese steel castings. It is a common and necessary practice among those who manufacture manganese steel to heat the article to approximately 950 degrees, plunge it into cold water and leave it until it is absolutely cold. This develops the characteristic toughness and increases the hardness to a higher point than it was prior to this treatment.

"I do not believe that flask annealing is as beneficial as removing the casting from the flask and reheating to the proper temperature, allowing it to cool slowly. In some experiments I had knowledge of, it was necessary to determine what was the best method of treatment to give a large mass. There were prepared from one and the same heat four or five solid cylinders measuring about 4 in. diameter and perhaps 6 ft. long. They were cast directly after each other in sand moulds. The first one was laid aside and tested in its ordinary condition; the second was annealed at a temperature of about 900 degrees, cooled in the furnace until it had lost all its colour and then removed and allowed to cool in the air. The next was annealed at 900 degrees and reheated to 750 degrees and then allowed to cool in the air. The next was annealed twice at 900 degrees. The next was annealed twice at 750 degrees. After they had been prepared in this way they were put in a large lathe and a nick cut around the outside; they were then broken and the structure examined. In annealing a steel casting the tensile strength is rarely reduced. If there is any change at all, unless it is a defective specimen, the tensile strength is almost invariably a trifle higher than in the original casting. Annealing does make a great difference in the elongation. Approximately the elongation is increased from two to three times; that is with large castings, not small ones."

Effect on the Structure.

"The cylinder in its unannealed condition," continued the speaker, "just as it was taken out of the sand, was broken and the structure over the entire surface was examined and found to be very large grains, octahedral in character, from ⅜ to ½ in. through the crystal. One blow of the drop broke this cylinder. The cylinder that had been heated to 900 degrees and cooled in the furnace until it lost colour, also broke at one blow, the difference in structure being noticed for about 10 in. from the outside. The coarse grains had disappeared, but the extreme centre was still coarse, showing that the treatment had not affected it throughout, and there was still a central core that seemed to be just as it was in the original casting. The next cylinder, which had been treated at 900 degrees and then at 750 degrees, showed practically the same appearance, the effect of the treatment having been felt for about 12 in. from the outside, but the grain was finer than that produced by annealing at 900 degrees only. The next cylinder, which had been annealed twice at 900 degrees, showed that the effect of this treatment had been felt almost to the centre. There was a small portion, perhaps 6 in., in the centre still coarse-grained. The one that had been treated twice at 750 degrees was very fine for 4 to 6 in. in from the outside, the remainder being coarse.

"The object of using these two temperatures was this:—If one can break up the coarse structure produced in a casting or forging at a low temperature, a finer and stronger grain will be got. But the coarse fracture that is produced in the large casting that cools slowly in the sand is not readily broken up at a temperature of 750 degrees. If one could anneal often enough at 750 degrees I believe a stronger casting would be obtained than when annealed at 900 degrees, but the amount of work and cost would be excessive. It is not practicable, so most manufacturers try to do their annealing at 900 degrees in order to break up the coarse structure and get the desired effect at a minimum cost. As a result of the experiments it was decided that for ordinary large castings, somewhat representing the cylinders mentioned, there was not enough good effect produced by a first annealing at 900 degrees and reheating at 750 degrees to justify the adoption of that treatment, and the treatment since that time has consisted of removing the casting from the sand, heating it up to 900 degrees and holding it there when that temperature is reached to give the grains time to rearrange themselves and allow for that chemical change in the carbon which occurs to a greater or less extent. After the casting has reached 900 degrees that temperature should be maintained for approximately 1½ or 2 hours to be sure that the change has taken place. Then one may begin to reduce the temperature in the furnace. I do not believe there is any real benefit to be derived from allowing a casting to soak a long time in the furnace. When it has reached the proper temperature throughout no further good can be accomplished by allowing it to cool down very slowly."

Mr. A. Stucki, in speaking of the high shrinkage of steel castings, often twice as great as that of cast iron, said that shrinkage cracks are the result of an improper distribution of metal which in many cases might be avoided in the design. At times, however, it is almost impossible to design a casting for a certain purpose so as to comply with the conditions as to machining or fastening and yet avoid the danger of shrinkage cracks. In the case of castings open at one end, U-sections for example, said the speaker, open ends are apt to spread, as the intervening sand will hold them apart. This trouble is remedied either by allowing for such spread in the pattern, by closing in the free ends under a press, or by connecting them by extra metal which can be removed as soon as the casting is cool. The latter method is often used to hold the pedestal legs of a locomotive frame in place. In driving-wheel centres the spokes cool more quickly than the rim, if not prevented by covering with sand, and will pull inward from the rim, producing cracks in the spokes or arms. The piping of castings which cool and reduce in volume may be prevented by large gates and large heads.

Accidents in Foundries.

With a view to eliciting information regarding the number of accidents in foundry and other industries, Mr. Henderson, M.P., recently addressed a series of questions to the Home Secretary, Mr. Herbert Gladstone, M.P. The question was first put as to the number of accidents, fatal and non-fatal, reported to certifying surgeons in 1908 in the metal-founding, textile, and shipbuilding industries, and what percentage they bore to the numbers employed in each case.

Mr. Gladstone replied that the number of accidents reported to certifying surgeons throughout the United Kingdom during 1908 in the industries mentioned was as follows:—

Industry.	Fatal.		Non-Fatal.	
	Cases.	Percentage of Employés.	Cases.	Percentage of Employés.
Metal-founding, &c.	96	0.04	6,215	2.3
Textile	82	0.01	6,344	0.6
Shipbuilding ...	116	0.08	1,260	0.9

In metal-founding and shipbuilding the figures as to persons employed were for the year 1904, and for the textile industries those for 1907, these being the latest available figures in each case.

Mr. Henderson then asked how many fatal and non-fatal accidents were reported by occupiers of iron foundries during each of the five years 1904-8; and whether it was possible to say what percentage of them was attributable to lack of proper lighting arrangements.

Mr. Gladstone, in reply, stated that the statistics at his disposal did not distinguish the figures for iron foundries from those for metal foundries generally. The following table, he said, showed the number of accidents reportable to the certifying surgeons in metal-founding in each of the five years 1904 to 1908:—

	Fatal Accidents.	Non-fatal Accidents reportable to the Certifying Surgeons.
1904	108	3,922
1905	125	4,654
1906	118	5,520
1907	151	6,798
1908	96	6,215

He also stated that it would require prolonged investigation to answer the last part of the question, but if Mr. Henderson had any facts in his possession tending to show that accidents result from the lack of proper lighting arrangements, he would suggest that they be brought to the notice of the Committee on Factory Accidents then sitting.

Mr. Arthur Henderson then asked the Home Secretary if he would state the number of foundries on the registers of the Factory Department; the approximate number in which advantage has been taken by employers of the Statutory Order No. 934, exempting foundries from lime-washing; and the approximate number of cases in which action has been taken by factory inspectors under Paragraph 4 of the said order by requiring the occupiers of such places to lime-wash or otherwise cleanse the whole or part of their premises.

Mr. Gladstone replied that in 1904, the last year for which returns were available, there were 2,331 factories or departments of factories in which iron-founding was carried on, 1,790 in which brass-casting, and 121 in which other metal founding was carried on. The information asked for in the last two paragraphs of the question was not available, and could not be obtained except at the cost of a laborious search through the registers and records of the different districts. Any specific cases would be considered and particulars obtained.

Mr. Henderson's Comments.

Commenting on this subject in the monthly report of the Friendly Society of Ironfounders, Mr. A. Henderson says:—

The number of these occurrences in factories and workshops assumed such formidable proportions in 1907 that the Labour Party concentrated attention on the problem, and succeeded in wresting from an unwilling Home Office a Committee of Enquiry dealing with this important question in its entirety. The alarming statistics covered the whole field of industrial enterprise, and the evidence of increasing numbers as well as that of degree of injury had a somewhat general application. A few occupations showed signs of improvement, and in these tangible reasons were available. Sometimes the welcome diminution in cases could be traced to efficient inspection on the part of Government officials. Instances of decreasing disablement are, however, to be found in only a few isolated trades, and certainly foundry work is not included under this heading. In fact, I fancy that the mutilation that has gone on in our works is unapproached and decidedly unequalled in that of any other process. The figures for 1908 show a big reduction in deaths, but a less significant decrease in non-fatal occurrences. The year 1908 was exceptional by reason of immense unemployment, and for other reasons which will be presently apparent. I shall leave it out of consideration at this moment.

The tale of progressive numbers is sufficiently pathetic when the subject is viewed in respect of 1904-5-6 and 7. Reference to the figures will show that Mr. Gladstone gave the following figures of fatal accidents in foundries:—1904, 108; 1905, 125; 1906, 118; 1907, 151. Now comparing the first with the last number it will be seen that in four years the deaths increased nearly 40 per cent. Many persons had hitherto regarded the cotton and woollen mills as the most prolific sources of disablement. But in 1908—a lean year—the deaths in foundries were 17½ per cent. greater than in textile works. There is, in addition, the important factor of numbers employed to be brought into account. According to the latest returns the textile trades employ 1,020,000 persons. From the same sources I find that workers in foundries of every kind do not total more than 350,000 persons. Hence, as the basis of comparison is about as three to one, it follows that relatively the deaths in foundries should at most not exceed a third of those in textile works. Instead of that the number is considerably greater. It is necessary to remember the fact of respective populations in this connection. We have it supplied to us in that light, and it comes out as follows: the percentage of fatalities to employés is in foundries 0.04, and in textile trades 0.01. It will assist us if we recollect the analogous percentage for railway work, which was 0.001. Briefly and approximately it is there-

fore three times safer to work in a cotton mill than in a foundry, and about 40 times safer on a railway.

Increase in Non-Fatal Accidents.

Turning to non-fatal accidents (Mr. Henderson continues), we find the position of foundry work with its attendant casuality list worse, absolutely and relatively, than any other trade. The term "non-fatal" is mysteriously comprehensive, since questions of degree are excluded. It may indicate either a severe or slight injury, a serious or light disablement. Burns, scalds, or other consequences of explosion are bracketed with accidents involving loss of limb—such as a hand or a foot, or destruction of some other equally important agent, such as an eye or ear. Therefore, we have, more or less, to regard the non-fatals as quite as terrible, seeing that a fair number cause permanent disablement. It is provided in the Act that accidents due to machinery, or to escape of gas, etc., are to be notified to a factory surgeon, and this attempt at discrimination is presumably the only known distinction between serious or slight injuries. That assists us to diagnose the case, because, roughly speaking, two-thirds of all accidents are reported to surgeons. In 1904 the number of non-fatal accidents was 3,922; in 1905, 4,654; in 1906, 5,520; in 1907, 6,798. Taking the period under review, we see that the number for 1907 is over 70 per cent. greater than that for 1904, while the twelve months ending 1907 show an increase of no less than 23 per cent. over the preceding year. This increase is more than twice the average increase for all occupations. When the matter was discussed in the House, Members were disagreeably surprised to learn that each year was augmenting the general total under the factory department nearly 10 per cent.; but in our foundries it is more than double that rate.

A comparison will show that foundries with a third the number of workers employed in cotton and woollen works have almost the equal of non-fatal accidents. In 1908 there were 6,344 accidents to textile operatives, while no less than 6,215 occurred in foundries. The percentage—in relation to employés—in textile works was 0.6, but in foundries it was 2.3—just about four times greater. It is even two and a-half times greater than all accidents in shipbuilding yards.

Contributory Factors.

One feature which also suffices to cause alarm is the inordinate number of disablements attributed to "escape of gas or steam, explosions, molten metal, and hot liquid." These together are more than half the whole. Taking causation as above, accidents in foundries are about three-fourths of those reported for the whole of the factories in the kingdom.

To summarise the facts we find that deaths in foundries increased 40 per cent. in four years, and that though the number of employés in the textile trades is three times that of foundries, the actual proportion of fatalities in foundries in 1908 was nearly double that recorded for the textile industry. With the same trade as a basis for comparison, we find that non-fatal accidents have a three times greater frequency in foundries than in textile works. There are other minor points which stand out from these conclusions, but they do not favourably affect the result, hence they need not be considered at the moment. It is an easy matter to tabulate the number of accidental occurrences, but not so easy to prescribe a remedy. Among contributory factors doubtless the question of insufficient lighting and inadequate protection of bogie ways is the most prominent evil. The fact of injuries scheduled from "molten metal, liquids, etc.," being so high confirms the indictment in this respect. Factory inspectors *might* do much this way—if these officials were conversant with foundry work. At present not a single member of the staff has had such practical experience. And we may at once conclude that many big changes must be made at the Home Office before we can get even this elementary justice. As previously mentioned, a Committee is at present investigating the whole field of accidents and some good results may be expected.

I have little doubt that the idea in 1904 of exempting certain foundries from the provisions relating to cleansing of walls, etc., has contributed in no small measure to many factors which help to make foundries such dark and dreary places. One can remember the dismal, uninviting appearance of places in which the artificial efforts at illumination seemed half absorbed by the grimy soot-laden walls. Now, there may be reasons for avoiding the expense and inconvenience of lime-washing foundry walls, but they are reasons which workers cannot recognise or countenance for a moment. Alternatively they have every reason to urge for a complete reversal of this exemption policy. I have, therefore, brought the subject to the notice of Mr. Gladstone. He has ample power to cancel the statutory order exempting foundries, and the evidences above stated are surely adequate to justify him doing so.

Letter from Accidents Committee.

The Accidents Committee of the Home Office have addressed a letter to the Ironfounders' Society, enquiring for information showing (A) whether there are now more accidents occurring per 100 persons employed in the trade with which the Society is concerned than occurred (1) ten or twelve and (2) three or four years ago, and (B) whether any general measures can be recommended for diminishing the number of accidents.

As regards (A), the Committee have already made an investigation of the textile trade, and the evidence given leads them to believe that in that industry the increase in the number of accidents reported is largely, if not entirely, due to the greater care and attention now given to the reporting of accidents, and that probably the number of accidents actually occurring now is very little, if at all, greater in proportion to the persons employed than the number occurring some years ago. They enquire whether, in the opinion of the Society, any increase in the number of accidents reported in the foundry trade may be set down to the better reporting; or if the increase is not wholly or partially due to better reporting, how it is to be accounted for.

THE SHEFFIELD ANNEALING WORKS COMPANY, of Warren Street, Sheffield, have received an order for a large Stobie patent tool-steel annealing furnace, together with gas-producer plant, from one of the more important German steel-making firms. The plant, which is the invention of Mr. V. Stobie, is capable of annealing 25 to 30 tons of crucible steel per week.

THE CARRON COMPANY, of the Carron Works, Carron, Stirlingshire, have just issued a handsomely-bound and profusely illustrated booklet in commemoration of the 150th anniversary of the foundation of the company. The illustrations include a number of specimens of the extensive collection of 18th century carvings from which many of the company's designs are still taken.

Baucher's Core-making Machine.

In the accompanying illustration is shown Baucher's patent core-making machine, by the use of which, it is claimed, the loss occasioned by the use of core boxes, and the expense of pattern-making for renewals for small core work is entirely obviated.

Among the advantages claimed for this machine are (1) that the mould being of cast iron, and machined out, guarantees a perfectly true core; (2) that the vent wire being a fixture for all cores ensures a perfect vent, and the simplicity of manipulation being such that a boy, with this machine, can easily make 100 per cent. more cores than with the old system; (3) that cores of any required length from ¼ in. to 12 in. long can be made by simply moving the handwheel.

The length of the cores being once determined the apparatus is locked automatically by the pawl on the pinion. Cores of various shapes, such as bolt-heads, ovals, square and bottle-neck or rectangular cores for flange pipes, etc., can be made by the aid of thimbles placed in the mould. This adaptability saves a considerable amount in pattern-making. The mould and die plate being of cast iron are practically indestructible; the rapid deterioration of wood boxes, through constant rapping, together with the attendant irregularities necessitating rubbing after stoving, is entirely obviated.

FIG. 1.—BAUCHER'S CORE MACHINE.

Referring to Fig. 2, A is a cast-iron core box; B is a cast-iron die plate; CD are wood thimbles, D being placed in first. The sand is rammed up to the required height, when C is placed in, thus forming a chambered core. E is a similar thimble for making a chambered core with square ends, and F a thimble for oval cores. G is a square box made to fit on the top of core box A, and so form a bolt-headed and chambered core, and H is a piece made to fit inside the core box A, with an oblong cut in it to form an oblong core, which may be cut to any length, and used for pipes, etc. All thimbles are made of wood, and generally in halves.

The dimensions of the machine are as follows:—Height, 33 in.; table, 30 in. by 20 in.; weight, approximately, 250 lbs.

The makers are Messrs. F. W. Baucher & Company, 18A, Ainsworth Street, Liverpool.

AMALGAMATION OF AMERICAN ALUMINIUM FOUNDRIES.—It was announced recently that the Aluminium Castings Company, which has been incorporated in Ohio (U.S.A.), is forming an important consolidation of aluminium casting establishments in the United States, and that the principal plant is to be located in Detroit. The Aluminium Castings Company, with a capitalisation of $800,000, acquires the properties of the Allyne Brass Foundry Company, Cleveland; the Allyne Brass Foundry Company, Detroit; the Allyne Brass Foundry Company, Buffalo; the Syracuse Aluminium and Bronze Company, Syracuse; the Eclipse Foundry Company, Detroit; and the United States Aluminium Company, New Kensington, Pa. All these acquisitions are made at one time. The capitalisation hardly represents the business, for the Allyne Company of Detroit alone turns out $1,000,000 of castings a year. The announcement of the consolidation follows on the heels of the purchase by the Allyne concerns of 23 acres of land in Detroit, on which large foundry buildings are to be erected at once. The Detroit plant, it is stated, will do the bulk of the business of the new organisation. It already does as much as all the other concerns entering the new organisation, and supplies fully 75 per cent. of the aluminium castings used in automobiles in America. Under the new arrangement the Aluminium Castings Company intends to continue to operate each of the plants except the Eclipse, and continue the business of each under its former management.

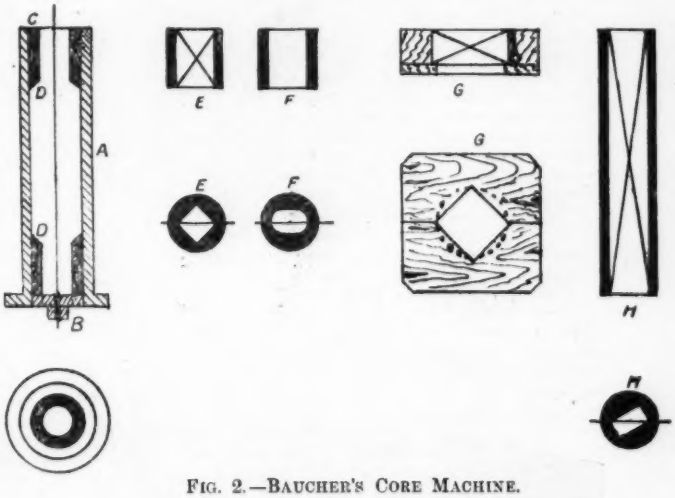


FIG. 2.—BAUCHER'S CORE MACHINE.

Some American Moulding Machines.

(*Continued from page 463.*)

The Mumford High-Trunnion Squeezer.

The machine shown in Fig. 17, which is a 10-in. high-trunnion squeezer, embodies numerous features. These are sufficiently indicated on the illustration to make a detailed description unnecessary. It is worthy of note, however, that the base of the machine is out of the way of the operator's feet. The plunger cannot be blown out. The ramming block lies flat on the ramming board at the moment of ramming, so that no air or time is wasted in passing an open space as in the low-trunnioned squeezer.

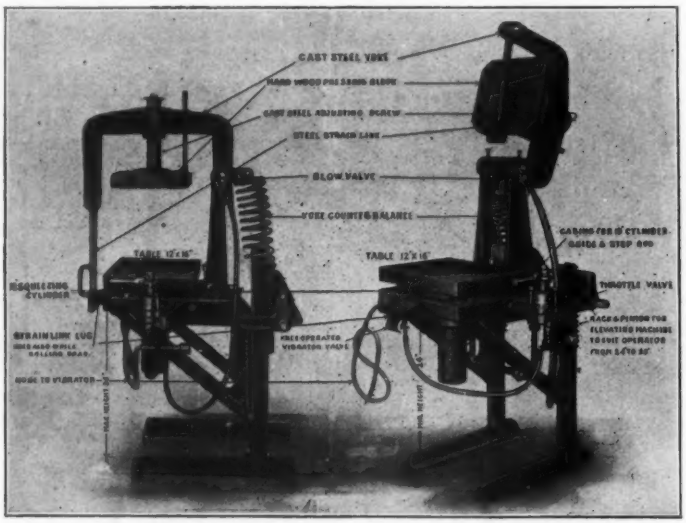


FIG. 17.—THE MUMFORD 10-INCH HIGH TRUNNION SQUEEZER.

FIG. 18.—THE MUMFORD PLAIN JOLT MACHINE.

The weight, mass and inertia of the parts which the operator must pull forward to ram are stated to be 30 per cent. less than in any other power machine of the same capacity, which means so much less jerk on the man's arm. In fact, the yoke takes itself up, back and out of the way as soon as hook is freed.

An interesting feature is the adjusting mechanism, allowing a variation of 12 in. in the height of the table, according to the height of the man operating the machine.

The makers are the H. E. Mumford Company, Philadelphia, Pa., U.S.A., for whom Messrs. J. W. Jackman & Company are the British representatives.

Mumford Jolt Ramming Machines.

Jarring, or jolt ramming machines employ the same principle as the moulder who bumps the flask on the bench to settle the sand. If the man has a place on his bench or on the floor where the mould is raised evenly and dropped solidly upon a firm anvil, this will comprise what may be called a plain joint ramming machine. Such a machine, as manufactured by the E. H. Mumford Company, Philadel-

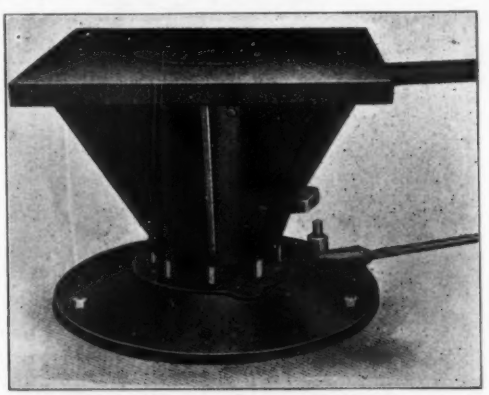


FIG. 19.—THE MURPHY JARRING MACHINE.

phia, Pa., is shown in Fig. 18. The firm have equipped these jolt ramming machines with pattern draft in various ways; by arranging attached pattern drawing mechanism, and by combining pattern drawing mechanism of independent construction separably attached to the machine. It has been found, however, that the jar of the structures surrounding the machine incidental to the jolting given the heavy moulds, militates against the maintenance of mechanism to roll over moulds or draw patterns if these structures are on, or in any way attached to the machines. The practice of equipping jolt ramming machines with pattern draft

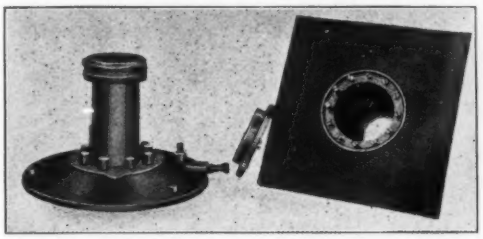


FIG. 20.—THE MURPHY JARRING MACHINE DISSEMBLED, SHOWING PISTON AND BASE AND THE TABLE CAST INTEGRAL WITH THE CYLINDER.

so situated as to be jarred by their action, has been abandoned by these makers. Among the points of importance which are put forward in connection with this mechanism are the following:—The machines have cast steel plungers and tables to secure the least possible dead load. There are impact surfaces under practically the entire table surface, insuring against vibration or overhang. There is a variable cushion, so that the character of the blow may be adapted to the work. The plunger is exposed only at top of cylinder and is protected by the table and guarded against the sand accumulating in the pit cutting plungers exposed lower down.

The Murphy Jarring Machine.

A jar ramming machine of somewhat novel construction has been invented by James A. Murphy, foundry superintendent of the Hooven-Owens-Rentschler Company, Hamilton, O., U.S.A,, and is in successful operation in the casting department of this concern. Instead of attaching the table to the cylinder, it is cast integral with it, thereby permitting the use of a larger table in proportion to the size of the piston. As shown in Fig. 19, the table is ribbed from the side of the cylinder supporting it at all points, thereby preventing any binding or twisting under the load at the moment of jolt or its downward stroke on the anvil. As shown in Fig. 20, the piston is stationary, being attached to the base, while the cylinder is arranged to move up and down upon it and carries the table with it. The impact of the table is taken on a series of steel pins arranged about the base of the machine. Compressed air is admitted at one side through a cut-off valve controlled by an adjustable tappet on the side of the cylinder. The valve proper rests on springs, and when air is turned into the machine the table is immediately raised. If the tappet is adjusted at its lowest point the cut-off valve is considerably below port entry at the beginning of the stroke, and air will not be admitted for a considerable portion of the stroke. As the tappet is run back, the springs throw the valve higher and higher, causing it to cut off earlier, permitting the air to be used expansively in the cylinder. When the piston reaches its highest point the exhaust port, which is practically continuous about the cylinder, is uncovered. The movement of the machine automatically operates the valve, which cuts off the supply of air at varying parts of the stroke, depending on the load, employing the inertia of the parts and the expansion of the air to do over one-third of the work

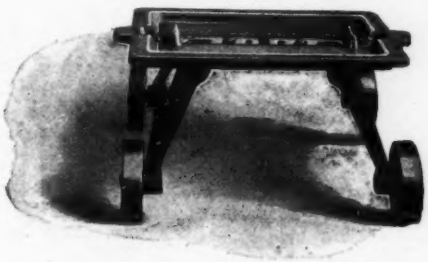


FIG. 22.—THE OSBORN MACHINE.

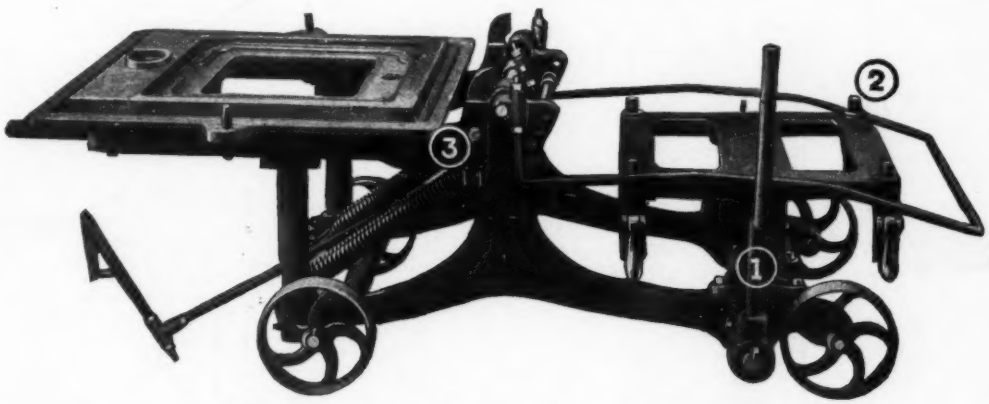


FIG. 21.—THE OSBORN ROCK-OVER DROP DRAFT MACHINE.

in some cases. At no time is the air entering the cylinder while it is exhausting.

The base of the machine is a heavy casting, the bottom of which is round in the centre. The machine will operate with any air pressure, but 80 lbs. is recommended, as it is claimed that the higher the pressure the better the results, and it will easily withstand 150 lbs. per square inch. For special work, such as engine frames, etc., the machine is built in two, three and four cylinder sizes.

The Osborn Rock-over Drop Draft Machine.

The outstanding features of this machine, which is shown in Fig. 21, are (1) it drops the mould by gravity, away from the pattern; (2) it is provided with an automatic adjustment at each of the corners of the delivery table, which compensates for any unevenness in the flask or bottom board; (3) it can be quickly adjusted to various depths of flasks. After the mould has been rammed, rocked over, the clamping device released and the machine vibrated, the workman pulls forward—either by hand or foot—a side lever and operates a cam which allows the mould to drop away from the pattern. The levelling device, which provides for any unevenness in the flask or bottom boards, variation in the amount of sand between the edges of the flask and the bottom board, and variations in the thickness of bottom boards, consists of four depressable pins working at the four corners of the delivering table. They adjust themselves automatically to any variation or unevenness and work independently of each other. They are quickly clamped into position, holding the flask true to the pattern until lifted to the floor. This ensures the mould drawing properly from the pattern. The adjustment device for various depths of flasks allows any of the three stock sizes of this machine to take drags or copes of any depth from 3 in. to 6 in. This considerably widens the range of work possible on one machine, and is a feature put forward as important to foundries that do not have long enough runs on any one pattern or depth of flask to employ one machine continuously. These Osborn machines, we understand are well adapted for stove castings and similar work. The three sizes accommodate flasks ranging up to 40 in. by 50 in., and each machine is accompanied by a dummy or cope stand, as shown in Fig. 22. Messrs. J. W. Jackman & Company are the representatives for this machine.

(To be continued.)

A New Fery Radiation Pyrometer.

In radiation pyrometers the heat radiated by the hot body is measured in various ways by the heat effect it produces, such as by the electric current set up when the radiation heats one or more junctions of two dissimilar metals, the expansion produced by the heating of a compound metal strip, or the change in resistance of a fine metal ribbon The radiation pyrometer, invented by Professor Ch. Féry, of the Ecole Municipale de Physique et de Chimie Industrielles, Paris, in which some of the heat rays from the hot body are concentrated by means of a concave mirror on to one junction of a small thermo-electric couple, has attained considerable prominence. The couple, when heated, sets up an electro-motive force, which is indicated on a galvanometer, the scale of which is divided in degrees of temperature. The great disadvantage of this form of pyrometer is the fact that a galvanometer has always to be used in conjunction with it; this necessitates a comparatively level spot on which to place the galvanometer, and the employment of leads to connect the pyrometer to the galvanometer.

FIG 1.—FRONT VIEW OF FERY SPIRAL PYROMETER.

Professor Féry has now, however, designed a new pyrometer which, whilst having practically all the advantages of the old instrument, does not require a galvanometer and leads. Instead of the heat rays being concentrated on a thermo-electric couple, they are focussed on a small bi-metallic strip made of two metals rolled into the form of a spiral, which unrolls when heated, owing to the largely different co-efficients of expansion of the metals used.

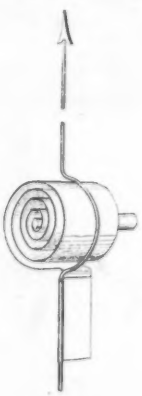


FIG 2.—THE SPIRAL (4 TIMES FULL SIZE).

Fig. 2 shows an enlarged view of the spiral, its centre being fixed, whilst its outer free end carries a light aluminium pointer which, as the spiral unfolds, moves in front of a scale calibrated in temperature. The spiral measures less than $\frac{1}{8}$th of an inch (3 mm.)

diameter, and $\frac{5}{64}$ ths of an inch (2 mm.) wide. It is blacked so as to absorb as large a quantity of heat as possible. Any radiation passing through its convolutions is reflected back on to it by means of a very small mirror placed behind it. Fig. 3 shows diagrammatically a sectional view through the instrument, A representing one of the heat rays which, coming from the furnace or hot body, strike the concave mirror C, and are reflected to a focus on the small spiral S. The pointer P moves in front of the scale D, the observation being taken through the glass window W. A shutter, not shown in the illustration, is provided in front of the instrument to screen off all radiated heat until it is desired to take a reading.

In order to eliminate errors which may arise through change in the actual temperature of the instrument, an adjustment is provided by which the centre rod supporting the spiral may be turned, and thus the needle set to zero on the scale. On opening the shutter and exposing the instrument to the heat rays the pointer will be seen to rise rapidly to some point on the scale and then to pause; this point is the temperature of the hot body. As the instrument, as a whole, gets hotter, the pointer will creep up slowly,

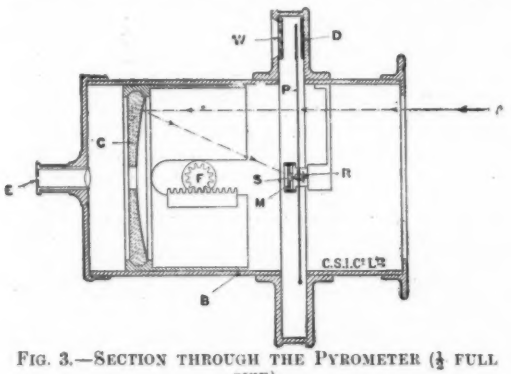


FIG. 3.—SECTION THROUGH THE PYROMETER (½ FULL SIZE).

and if the pyrometer is left in position for a comparatively long while then a second zero reading must be taken and a correction applied for the new zero reading. Extreme scientific precision is not claimed for the new instrument, but an accuracy of between 1 per cent. and 2 per cent. is readily obtainable.

The following table shows the result of some comparison tests made by Mr. G. C. Pearson at the Birmingham Gas Works between a standardised thermo-electric Féry radiation pyrometer and the new spiral type of instrument:—

Fery.	Spiral.	Difference	Fery.	Spiral.	Difference.
990	990	0	995	1,000	5
930	940	10	980	978	-2
1,000	1,005	5	1,210	1,218	8
1,020	1,020	0	1225	1,220	-5
1,250	1,020°–1,270	—	1,250	1,250	0
1,240	1,238	-2	845	840	-5
1,260	1,260	0	—	—	—

* Variation due to draft, to the effect of which the new instrument would appear to be much the more sensitive.

The instrument is portable, and is supplied with a light, rigid, wooden tripod. Fig. 1 shows the front view of the pyrometer with the temperature scale and pointer. As at present constructed the instrument is made with three different scales, which it is believed will cover most commercial requirements. These scales are:—(1) 500 degrees to 1,100 degrees C., which will cover practically all annealing, hardening, and case hardening temperatures. (2) 500 degrees to 1,400 degrees C., which will cover practically all the temperatures met with in gas works, the pottery trade, etc. (3) 500 degrees to 1,700 degrees C., covering any temperature in a steel works.

In order to get true temperature readings with this, and all types of radiation pyrometers, the condition which should be fulfilled is that the hot body sighted on should be contained within a chamber, the walls of which are at approximately the same temperature as itself. This condition is, of course, fulfilled in most practical cases. The error caused by the fact of the furnace door being open when sighting is negligible, especially as the instrument is calibrated under these same conditions. If it is desired to take observations without opening the door of the furnace or making any opening in the wall, the arrangement illustrated by Fig. 4 may be adopted. A cast-iron or fireclay tube is built into the furnace wall, the tube being closed at the end A, which is inside the furnace and open at the other end. Since the tube takes up the temperature of the furnace for some distance along its length, it fulfils sufficiently closely the required con-

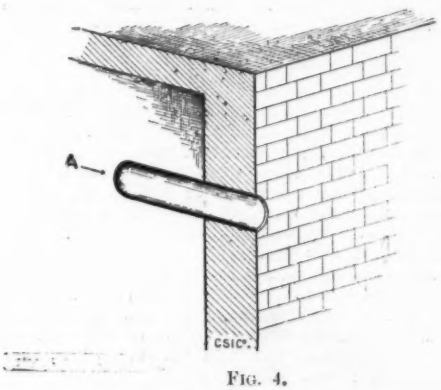


FIG. 4.

ditions of a closed chamber, with walls at the high temperature, and, therefore, by sighting on the blind A, the true temperature is obtained without any cold air finding its way into the furnace or flames coming out.

This new Féry pyrometer is being constructed in this country by the Cambridge Scientific Instrument Company, Limited, who have also the sole manufacturing and selling rights in the Colonies and the United States.

THE ELECTRICAL PRODUCTION OF PIG-IRON.—The Swedish patents of Messrs Grönvall, Lindblad & Staalhane, for their electric shaft furnace has now been definitely accepted by the patent authorities. The patent rights are said to have been sold already to Domnarfvet and to the Udeholm Works. A separate company with Swedish capital has also been formed for the production of pig-iron at the Trollhättan waterfalls, and negotiations are being carried on with other works in Sweden, intending to utilise the patent rights. According to an estimate the cost of the production at the Trollhättan Works will amount to 56s. per ton. British pig-iron costs at present about 51s., while the Swedish charcoal pig-iron fetches about 66s. per ton.

"Kish" and the Making of Solid Valve Castings.*

By W. D. Rudy.

It is a matter of concern to every founder to be able to turn out good-looking castings, but he should be still more desirous to have them solid and close throughout. Especially should this be the case in valves, cylinders, and other castings that must withstand high pressure, or castings that will be subjected to deep cuts in machining and finishing.

A large percentage of this trouble, which results in castings being found defective on machining, can be classed under the head of "Kish." This "kish" is not dirt, as it is often termed, but graphitic carbon that is squeezed out of the cooling metal, and has collected in the heavy parts which cool last. This separated graphite is constantly pushed ahead of the line of cooling until it reaches the last-liquid part of the casting. In a large casting the accumulated bulk of graphite thus separated from the iron forms into a spongy mass mixed with a small amount of oxidised iron. This is "kish."

Reduction of the Graphite.

The obvious way to avoid this is to reduce the graphite. To lower the graphite, the most practical and easy method is to cause more of the total carbon to remain in the combined form; or, in other words, to endeavour to produce a condition that is unfavourable to the separation of carbon from cooling iron in graphitic form. It is a well-known fact that lower silicon, higher manganese, and higher sulphur in the iron will decrease the tendency of that iron to throw out its carbon in the form of graphite. The cure lies in our hands. The greater the mass of the casting, the lower silicon, higher manganese, and higher sulphur it should have to avoid this formation. In small castings where the "set" is very quick, this difficulty is never met.

The proposition is to use a mixture low enough in silicon to avoid this tendency without too great hardness or liability to breakage in the smaller sections, yet strong and tough enough to withstand the practical stress to which the casting may be put. To assist in this and secure the desired toughness the manganese must be regulated. As a third factor, the combined carbon can be raised by a moderately high sulphur yet not high enough to produce hardness.

It would be impossible to lay down any hard-and-fast rule for the work. Each class of castings has individual peculiarities which must be taken into consideration, such as construction, usage, required machining, etc. An illustration from actual everyday practice is the best way to convey an idea of the proceeding.

A Typical Example.

Suppose it is required to cast an ordinary 18-in. valve. It has been the general practice of founders to cast this valve out of iron containing about 2 per cent. silicon, leaving the other elements mostly to chance. Some use a certain percentage of steel in the mixture, a practice not advisable in valves. Of course, this does not apply to those who are compelled to conform to buyer's specifications which are often greatly at fault. It is often found very difficult to cast a valve that would not show kishy spots and sponginess in the flanges and seats when broken.

To do away with this fatal weakness, at the same time adding to the strength and closing the grain of the metal without making it in the least hard or brittle, the writer has recommended and seen used with success a mixture containing about 1 per cent. silicon; 0.90 per cent. manganese; 0.50 per cent. phosphorus, and 0.10 per cent. sulphur. To the majority of valvemakers this will seem a radical departure. When it is noted that the tensile strength of this metal is as high as 30,000 lbs. per square inch, as compared to a maximum of about 22,000 lbs. for 2 per cent. silicon iron, the departure would appear to be at least an improvement.

Now as to mixtures best suited for this work. Many founders continue to make these valves with what might be described as a jobber's mixture. Its analysis would approximately be silicon 2 per cent., manganese 0.40 per cent., phosphorus 0.70 per cent., and sulphur 0.10 per cent. The mixture would probably consist of iron and scrap, the analysis of which would be quite unknown, and the mixture's chief recommendation would be that it had given good results previously. Other users for special work add to a similar mixture a fixed amount of ground ferro-manganese or some patented "compound" to the iron in the ladle. The worst feature of this is that a variation in the analysis of the pig-irons may cause it to do more harm than good by increasing the brittleness instead of the strength. The grain is closer, however, which appears to satisfy most melters of this class.

Again, we have another class of founders who get around the difficulty by the use of 30 to 40 per cent. of steel in their mixtures. They come nearer the correct solution than either of the former, because they lower the silicon and thus close the grain, and also reduce the total carbon. Their chief error, however, lies in the fact that they also decrease the manganese as well. This permits an excess of carbon to remain in the combined state upon solidification. The result, although a close-grained iron, is a metal that is "short," namely, extremely likely to sudden rupture under varying stress. It has a decided tendency towards hardness, and, finally, in subsequent machine work the tool is likely to tear out small granular particles instead of cutting a smooth clean finish. This latter tendency is probably because the carbon in steel is often in a different form from that in the combined form in cast iron; it may appear in the casting in that form, segregating in minute hard-spots. For these and other reasons many consumers specify that semi-steel must not be used in making their valves.

The Value of the Chemist.

As a general principle, the writer contends that 10 per cent. of steel should be the maximum amount in any mixture for this class of work, only to be used when the analysis of the other components renders it necessary to secure the proper analysis points. The up-to-date founder, upon being confronted with this problem, consults with his chemist, and learns:—

That the maximum density of cast iron occurs when the silicon is at 1 per cent. At this point it weighs 480 lbs. per cubic foot, whereas with 2.5 per cent. silicon it weighs only 430 lbs.—a rather startling difference to one noting it for the first time. Between these two percentages of silicon there is a proportionate range of density.

* "Castings."

That the strongest iron at 1 per cent. silicon contains just a trifle over 1 per cent. manganese, its strength lessening with corresponding decreases in the amount of manganese.

That the increase in the percentage of manganese, up to 1 per cent. tends to produce a fine, close grain, tough but easily machined.

That with 1 per cent. each of silicon and manganese, the strongest cast iron contains about 0.10 per cent. sulphur.

That the lower the phosphorus, consistent with the necessary fluidity, the greater is the strength.

That there is more shrinkage in the iron when the phosphorus is under 0.50 per cent. than when it is above that point.

With this information he sets to work. He seizes upon 1 per cent. silicon as the producer of the most dense iron possible, knowing that he must have no "sweating" under a severe hydraulic test. Wishing to get the maximum strength, or as near it as possible, he decides to make the manganese 1 per cent. But, on second thought, in order to be on the safe side as far as machining is concerned, he cuts it to 0.90 per cent. As to the sulphur, he sees no reason for not using the figure for maximum strength without hardness, so 0.10 per cent. is set as the figure. The phosphorus he decides to place at 0.50 per cent., knowing that the question of fluidity is not an important factor in his 18-in. valve, at the same time wishing to get the maximum strength with the least possible shrinkage. The result is the following specification, under which he proposes casting his valves: Silicon, 1 per cent.; manganese, 0.90 per cent.; phosphorus, 0.50 per cent.; and sulphur, 0.10 per cent.

The question of material now arises. He finds that he has on hand, in addition to his regular stock of foundry iron, a pile of grey forge iron, some No. 3 pig with very high manganese, and a lot of selected machinery scrap.

The pig-iron had been analysed when it came into the yard. His experience in mixing by analysis has shown that the following analysis is a reliable approximation for good machinery scrap. His stock lines up thus:—

	Si.	Mn.	P.	S.
No. 3 high Mn.	1.26	2.03	0.652	0.031
Gray forge pig	0.58	1.01	0.311	0.062
Machinery scrap	2.00	0 50	0.700	0.100

With the above materials he finds he can very readily construct a mixture that will conform to his specifications, and sets it down thus: Grey forge, 50 per cent.; No. 3 high manganese, 20 per cent., and machinery scrap, 30 per cent.

He figures out the analysis of his mixture, and allows in the percentage of silicon 10 per cent. for the loss by oxidation in melting. For the same reasons 15 per cent. of the manganese is allowed. The sulphur will show a net gain of 0.035 per cent. on account of the absorption from the coke. With these corrections to his figures, the resulting casting should have the following analysis: Silicon, 1.03 per cent.; manganese, 0.91 per cent.; phosphorus, 0.495 per cent., and sulphur, 0.102 per cent.

This is very close to his desired mixture point, and he charges a sufficient amount of this mixture to cast his valves, following it in the cupola by his regular grey-iron charge.

As a result of his care and attention he is able to make a valve that is extremely close and tough, machines very readily and takes a smooth, high polish. Furthermore, the casting has a smooth skin and good appearance, there are no sulphur holes or shrinks and, best of all, the valve will stand any reasonable hydraulic test.

The Costs.

Now as to the cost of this excellence. Let us assume that No. 2X pig-iron sells at $17 delivered, and No. 2 plain at $16.50 delivered. At such pig-iron prices machinery scrap will command $15.25 in the market. Grey forge or off-basic pig will sell at $15.75 as a maximum price under above conditions. The high manganese iron, No. 3 in grade (any one of six brands the author has in mind) will cost $16.50. Ferro-manganese costs 3½ cents.

The first-mentioned "jobbing" mixture would work out at about $16.15 per ton; the second, using an addition of 2 lbs. of ferro-manganese per 1,000 lbs. of iron, would probably total up to $16.22; the semi-steel would work out at about $15.80 per ton; and the last and best mixture would cost about $15.63 per ton.

These figures are from actual practice, and the prices are correct on the basis of the market at the time the experiments were made. The comparison will hold on any market.

Thus it is readily seen that, instead of costing more the "special" mixture costs considerably less. This is encouraging, giving as it does a saving as a margin with which to help pay for the necessary analytical service. In addition, there is the supreme satisfaction of knowing that the work is better than the competitors.

This is merely one illustration from the many cases that come up every day, wherein a little knowledge, a little judgment and a little careful attention will not only produce results that are a constant credit to the founder, but permit an actual reduction in the cost of the metal. When this is added to the profits from lowered shop losses consequent upon having the proper kind of iron, it assuredly looks like a good proposition.

The businesses of the Atlas Machinery Company and Graham, Sons & Company, machinery merchants and engineers, 112, Waterloo Street, Glasgow, carried on by Mr. S. Graham, engineer, 41, Benview Street, Glasgow, have been sold to Mr. P. Taylor, shipbuilder and engineer, 69, Park Drive South, Whiteinch, Glasgow.

The International Time Recording Company, 151-153-155, City Road, London, E.C., recently received a repeat order for 12 automatic two-colour time recorders from Marshall, Sons & Company, Limited, Gainsboro', also further orders from the Municipal Council of Shanghai, Imperial Japanese Navy, and the Woolwich Arsenal.

At a meeting of the first mortgage debenture holders of Messrs. John Abbot & Company, Limited, iron-makers, Gateshead, held in Newcastle, recently, it was resolved that Mr. James Harrison, of the firm of Messrs. Monkhouse, Goddard & Company, chartered accountants, and Mr. Robt. B. Ferry, secretary of Messrs. Abbot & Company, be appointed receivers to wind up the business and realise the assets. It is understood that the receivers intend to carry on the business for a time in order that the practicability of a reconstruction scheme may be considered. Messrs. Abbot & Company's Works were established nearly a hundred years ago. When in full operation as many as 1,500 or 1,600 men have been employed.

Brass Foundry Practice.

By J. Clements.

Pump Boxes.

The first castings which will be here described are pump boxes, and in the series of illustrations Fig. 1 will be seen the wire or core iron A (the foundation of the core), the core boxes B, B, B, showing the chambers formed by the insertion of this core when made, and the pump cores C, C, C. Fig. 2 shows the box casting D, D, and the patterns on the plate, E, E.

As many of these castings are wanted, naturally they are made on the moulding machine and in three boxes or flasks. This is a class of work for a good and careful moulder, but not one that sleeks down every part several times and stops up the natural vents of an otherwise open sand. The sand must not be at all wet, but worked as dry as possible, so as not to

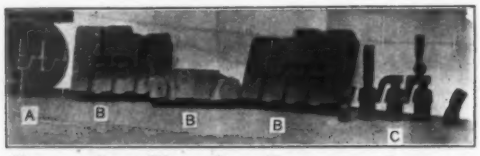


FIG. 1.—CORE WIRE, CORE BOXES AND CORES FOR PUMP BOXES.

generate steam, as this might ultimately be detrimental to the soundness of the casting. The patterns are mounted on plates, as shown in Fig. 2, and worked from an ordinary turn-over machine, being rammed up in the usual way and vented where possible, especially under the flange shown. This, too, requires care in ramming, as owing to the flange part of the casting being in the drag side, any gases present are not so easily got rid of; hence the best plan is to vent this part well, and use a dry or open sand. Owing to the construction of some of the branch cores that fit up to the large or body core, it is not always possible to cast the flange in the lower part of the mould. The branches of the core in this

FIG. 2.—PUMP-BOX CASTINGS AND PATTERNS ON PLATE.

case being laid in the mould, and the body part being put in next and fitting on to the branches, the gating of the casting calls for no particular comment; on the other hand, the casting requires a good hot metal, and instead of teaming it as usual, it should be poured rather slowly at first, to let the gases that will be liberated get away without hindrance. The flow of metal should afterwards be increased, bringing up the head in gate with a little more vigour. With these precautions much sounder castings will result.

As will be seen from the illustrations, there are many chambers and outlets, plug-way, etc., in these pump boxes, and to clean these out the best method is to blow out the cores. After the moulds are cast and the metal is set, the castings are taken from the sand, and the gate and runners are knocked off. Then the casting is suddenly plunged into a tank of water kept for the purpose, with a tap over it; by this method the core is got away infinitely cleaner than would otherwise be the case. The sand and metal that accumulate in this tank are from time to time removed, and the wires sorted out, the remainder being ground and washed to extract any metal remaining.

Slide Valves.

Fig. 3 illustrates the making of slide valves. The efficiency of slide valve castings should always be

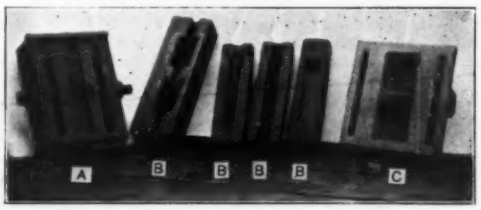


FIG. 3.—PATTERN AND CORE-BOXES FOR SLIDE VALVES, AND THE COMPLETE CASTING.

above suspicion. First, the material or alloy has to be considered. This should be extremely hard, preferably of phosphor-bronze, this alloy being dense and hard-wearing, as the renewal of a valve of this description through failure is attended with serious consequences. Gun-metal or other bronze would not answer the purpose so well, and the cost would be much greater for a relatively hard alloy, whilst the properties would fall short of the requirements.

FIG. 4.—SLIDE VALVES IN THE MAKING.

In making up the slide valve it is best to consider whether it shall be made in dry or green sand; assuming the latter, then great care is required. In Fig. 3 will be seen the pattern A, the core boxes B, B, B, from which the cores will be produced with the aid of cores wires, and a casting C. To make these valves it is generally necessary for a 3-part box to be used, the centre part usually being the depth of the valve, the top and bottom sides containing the prints of cores. In laying these cores in the drag side, it is necessary to rub or produce a small gutter along the

part of core to be set in the print. This is done merely that the sand may be well rammed round these prints, and to insure the cores being held firm, and then it is necessary to try them with a straight edge, to see they are truly set, as otherwise the efficiency of the valve is jeopardised. Having finished and closed the mould, the next consideration is the metal or alloy. In dealing with this there are several points of importance. In the first place care must be exercised in melting and making the alloy, so as not to burn the metal, and the moulds must be ready in time, so as not to keep the metal in the fire, as much harm is done by so doing. Then, in actual pouring, there comes the question of heat, and this can only be determined by actual experience, whilst the metal wants thoroughly melting so as to eliminate any dross or impurities. It cannot, however, be poured in this condition, but wants cooling down considerably till it looks much more dull than when lifted from the furnace, and as scrap is added from time to time this will soon be noticeable. Many castings that would in other alloys be run with the bulk of the casting in the drag side, may be run the other way up in the cope with phosphor-bronze, the casting being, in fact, much better and cleaner by so doing. On the other hand, if the metal is cast too hot it will segregate, and also the castings will most likely be very rough and require much fettling, while at the same time not machining up well. Finally, owing to its penetrating power, only very small gates are necessary for running the castings in the metal. Fig. 4 shows the valves in the making.

"Fluxine" Metal Cleanser.

Owing to the low melting point of tin (232 degrees C.) and zinc (419 degrees C.) in comparison with that of copper (1,065 degrees C.), it is evident that if a proper preventive is not employed, oxidation of the former metals will take place, entailing a loss in brass of from 2 to 5 per cent. To overcome this, a metal cleaner, known as "Fluxine," has been placed on the market by Messrs. J. W. Jackman & Company, Limited, and by the use of this it is claimed that pure and clean metal can be made out of old waste, scrap, turnings, borings and grindings. The oxides existing in the metals previous to melting are stated to be reduced by "Fluxine" to their metallic state. It eliminates gases, preventing the formation of pores and blow holes, and thereby increases the tensile strength of the metals. This preparation, which is practically infusible, forms over the metal a dense cover, guarding against atmospheric influences. The heat of the metal is also thus retained.

When using this material in crucibles, the necessary amount is placed in the crucible immediately after the first charge has melted. This ensures the ready removal of any iron with which the mixture has been contaminated, as "Fluxine" combines readily with iron, keeping it in a free state at the top and separate from other metals. It can, therefore, be easily skimmed from the surface upon the removal of the crucible from the furnace.

When using the material in oil furnaces, it must be placed in the bottom of the furnace. The metal is then charged and in the course of melting it gradually passes through the "Fluxine," the latter rising to the top and forming a dense cover over the mass, preventing further oxidisation. Immediately before pouring, iron and other impurities can be readily skimmed from the surface.

Various other materials are often employed to prevent oxidation of metals and to ensure a pure product, but in each case their use involves some disadvantages. Charcoal does not remove iron and other impurities; ground coke frequently contains sulphur and iron, which infused into metal prove most objectionable; fluorspar has a great affinity for silicious material, and therefore severely attacks the crucible; cyanide of potassium, on account of its poisonous qualities, is a dangerous material to use; and glass is of an uncertain composition and frequently carries iron and lead.

It would appear extremely difficult to obtain a material free from all these objections and suitable for the purpose, but it is claimed that "Fluxine" is subject to none of the foregoing objections, while at the same time combining the virtues previously named.

HADFIELD'S STEEL FOUNDRY COMPANY, LIMITED, of the East Hecla Works, Sheffield, have received an order from the Mond Nickel Company, of Canada, for jaw crushers, valued at about £4,000.

MESSRS. TETLEY & COMPANY, of the Falcon Electrical Works, Greengate, Manchester, have appointed Mr. S. M. Jones, 7 & 8, Western Mail Chambers, Cardiff, and 63, Wind Street, Swansea, as their Welsh agent.

WILLANS & ROBINSON, LIMITED, of the Victoria Works, Rugby, have recently taken up the manufacture of centrifugal pumps, for dealing both with high and low lifts, and have at the present time some twelve pumps under construction.

MESSRS. F. COCKAYNE, J. COCKAYNE, and C. E. MEDCALF, consulting and general engineers, Derby, Burslem, Longport, Staffs., and Birmingham, trading under the style of Frederick Cockayne & Company, have dissolved partnership.

MR. H. ELLISON WALKER, of Cardiff, who has been for many years agent for Crossley Brothers, Limited, has been appointed the Welsh and West of England representative of John Cameron, Limited.

A. F. PARKES & COMPANY, LIMITED, edge tool makers, Birmingham, are rebuilding and enlarging the warehouse at their Aston Works, and are making provision for shopping accommodation in the basement.

A DISSOLUTION of partnership is notified in connection with Messrs. W. H. Wass and H. Bolsover, metallurgists, etc., Sheffield, who traded under the style of the Yorkshire Analytical and Mechanical Testing Laboratories.

THE proprietors of "Cassier's Magazine," the well-known engineering monthly, have issued a new trade paper called "The Metal Industry," which will be devoted exclusively to the non-ferrous metal trades. The paper is published at 6d. per copy.

An Investigation of the Basic Bessemer Process.

F. Wuest and L. Laval, German engineers, have submitted the basic Bessemer process, as carried out in everyday practice, to a close experimental examination. The results have been published in "Stahl und Eisen." They give very interesting and valuable data concerning this process, both from a practical and theoretical standpoint, the results serving toward the formation of a balance sheet of the materials employed and the heat units and to the consideration of what changes would be brought about in the heat balance by the use of dry air, hot blast or blast enriched with oxygen. We present herewith a translation in abstract, by the "Iron Age," of the paper:—

Metal Analyses.

The weight and compositions of the materials employed in the charges examined are given in Tables I. and II.:—

TABLE I.—*Weight of Materials.*

Charge No. 1, Nov. 3, 1905. Material.	Pounds.	Charge No. 2, March 21, 1907. Material.	Pounds.
Pig iron	23,093	Pig iron	23 721
Lime	293	Scrap	617
Ferromanganese ...	154	Lime	3 880
Ferrosilicon	44	Ferromanganese ...	132
Spiegel	1,543	Steel	20,105
Steel	2,145	Ladle slag	6,658
Ladle slag	5,798		

TABLE II.—*Analyses of Fluxes and Materials.*

	SiO_2	Fe	Mn	Al_2O_3	CaO	MgO	P_2O_5	S	Water and CO_2
Lime ...	0.40	0.09	Tr.	0.19	85.10	Tr.	0.007	0.135	14.078
Dolomite	3.44	2.29	0.15	1.09	42.45	16.45	0.221	0.149	33.260
				Car.	Sil.	Man.	Phos.	Sul.	
Ferromanganese				6.33	0.21	76.70	0.265	0.017	
Ferrosilicon				0.00	48 33	0.38	0.037	Tr.	
Spiegel				4 58	0.47	9.52	0.049	0.008	

In Table III. are given the analyses of the pig-iron, the finished steel, and the tests taken at different intervals throughout the blow:—

TABLE III.—*Analysis of Metal Tests.*

Blowing time. Minutes.	No.	Car.	Sil.	Man.	Phos.	Sul.
	Charge No. 1.					
Pig iron.	3.354	0.481	0.85	2.009	0.177	
0 to 1½	1	3.081	0.036	0.80	1.998	0.098
1½ to 3½	2	2.624	0.006	0.42	1.910	0.120
3½ to 5½	3	1.934	0.007	0.41	1.866	0.128
5½ to 6½	4	1.321	0.009	0.45	1.786	0.128
6½ to 8½	5	0.733	0.010	0.55	1.735	0.128
8½ to 10	6	0.094	0.005	0.52	1.436	0.112
10 to 11½	7	0.031	0.009	0.55	0.526	0.067
11½ to 13½	8	0.015	0.009	0.34	0.117	0.084
13½ to 15	9	0.016	0.013	0.23	0.066	0.077
Steel		0.26	0.033	0.58	0.097	0.039
	Charge No. 2.					
Pig iron		3 42	0.83	1.06	1.789	0.092
0 to 2	1	3 29	0.02	0.54	1.785	0.073
2 to 4	2	2.85	0.012	0.39	0.033	0.086
4 to 6½	3	1.85	0.008	0.26	1.586	0.095
6½ to 8½	4	0.92	0.009	0.24	1.526	0.091
8½ to 10	5	0.025	0.007	0.18	1.386	0.107
10 to 12½	6	0.014	0 008	0.24	0 134	0.062
12½ to 13½	7	0.014	0.007	0.1°	0 041	0.043
13½ to 14½	8	0.014	0.007	0.16	0.029	0.034
Steel		0.16	0.007	0.26	0.050	0.040

The silicon shows a great difference in the two heats, being 0.48 per cent. in the first case, as against 0.83 in the second. In the first 3 minutes it is oxidised to a mere trace, and from the third minute remains at about the same height.

The manganese is lowered in both heats to about 0.45 per cent. in the first 3 minutes. From the third minute the manganese percentage changes in an essentially different way: With the first charge it keeps at about the same height to the fifth minute; it then increases, as observed in 1879 by Windsor Richards, being supplied directly by reduction of the oxide of manganese. This reduction is most probably brought about by the phosphorus, which is certainly the case after the tenth minute, the manganese again increasing slightly in the bath from which the carbon has almost entirely disappeared.

The sulphur acts about the same with both charges. It decreases with the first 2 minutes, especially in the first heat, which has a very high percentage to begin with. It then increases slightly, and again decreases after the tenth minute. The total desulphurisation is about 56 per cent. in charge No. 1 and 60 per cent. in charge No. 2.

The carbon is slightly lower in the pig-iron of charge No. 1, being 3.35 per cent., compared with 3.42 per cent. The slight loss in the first 2 minutes of charge No. 2 is striking, and is undoubtedly due to the high silicon contained in this heat.

The phosphorus remains in both cases at the same percentage for the first 2 minutes; then, from the second to the eighth minute there is a small but noticeable decrease. It amounts to about 0.2 per cent. with both heats. With charge No. 1, 0.6 per cent. of phosphorus is oxidised together with the carbon, which equals 33 per cent. The other charge shows a smaller oxidation namely, 22 per cent. The colder the charge the greater will be the amount of phosphorus oxidised with the carbon.

The statement is often found in text books that the phosphorus first begins to be removed from the bath after the carbon, but from the foregoing results it is evident that this is not wholly the case. Such a statement must be rectified, for about 25 per cent. of the phosphorus is removed together with the carbon, while the chief part is attacked after the carbon is almost completely oxidised. The last 75 per cent. of the phosphorus needs about 3 minutes for its removal.

Slag Analyses.

In Table IV. are given the analyses of the slag tests:—

TABLE IV.—*Analysis of the Slag Tests.*

Blowing time. Minutes.	No.	MnO	Al_2O_3	MgO	P_2O_5	SiO_2	CaO	CaS	FeO	CO_2 + H_2O
		Charge No. 1.								
0 - 1½ ...	1	0.84	0.20	0.00	0.05	2.88	79.84	0.63	0.84	14.72
1½- 3½ ...	2	8.27	0.22	0.00	2.08	13.14	58.85	0.76	4.44	9.31
3½- 5½ ...	3	5.04	0.20	0.00	2.48	7.74	67.20	0.51	2.04	14.79
5½- 6½ ...	4	4.02	0.20	0.00	2 29	7.72	68.27	0.60	1.90	15.50
6½- 8½ ...	5	2.81	0.23	0.00	2.96	4.98	69.93	0.70	2.32	16.07
8½-10 ...	6	5.89	0.26	0.64	5.40	12.25	62.95	0.72	4.65	7.76
10 -11½ ...	7	3.13	0.70	1.74	21.11	8.17	58.28	1.69	4.16	0.00
11½-13½ ...	8	4.60	0.82	2.79	21.66	6 53	48.92	1.19	13.30	0.00
13½-15 ...	9	4.19	0.92	2.89	17 88	5.17	43.31	0 93	24.80	0.00
		Charge No. 2								
0 - 2 ...	1	3.75	0.27	0.52	0.66	8.00	68.3	0.37	1.31	16.10
2 - 4 ...	2	5.72	0.33	0.81	2.26	8.80	65.1	0.42	2.64	12.81
4 - 6½ ...	3	4.74	0.34	0.64	2.87	6.89	63.0	0 53	2.90	17.31
6½- 8½ ...	4	4.26	0.51	0.86	2.81	6.90	63.68	0.50	3.30	16.59
8½-10 ...	5	5.50	0.64	0.91	6.36	12.10	58.8	0.72	4.64	7.58
10 -12½ ...	6	4.86	0.70	0.98	19.64	8.74	52.46	0.56	10.24	0.25
12½-13½ ...	7	4.72	0.72	2.87	14.80	6.34	49.88	0.18	18.20	0.61
13 -14½ ...	8	4.23	0.57	2.89	11.57	6.05	47.82	0.18	25.58	0.86

At the beginning of the process the slag is not thoroughly molten, so that in the test ladle pieces of lime are removed covered with a thin coating of slag. The analyses of the first tests are, therefore, not altogether reliable. It can be seen, however, that in charge No. 1 the lime contents drop remarkably quickly from the first to the third minute. This is not only due to the formation of silica, but to the oxidation of considerable iron, owing to the cold condition of the charge. Then, owing to a reduction of

iron and manganese back again into the bath by the carbon, the lime contents increase up to the eighth minute, when they again decrease, accompanying a clear gain in phosphoric acid. The P_2O_5 reaches its maximum in the twelfth minute, after which it is somewhat diluted in the slag, owing to a considerable oxidation of iron. The lime contents of the slags of charge No. 2 show a somewhat similar relation.

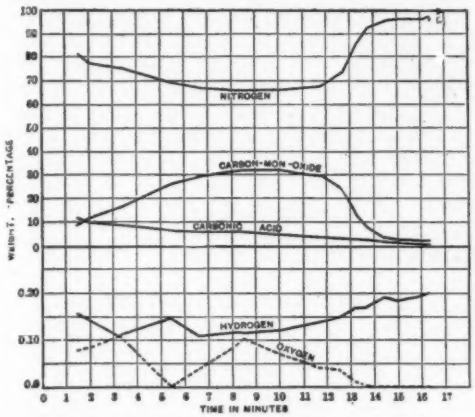


FIG. 1.—AVERAGE COMPOSITION OF GASES.

Concerning the oxide of manganese, the cold condition of charge No. 1 immediately occasions a considerable formation, as well as that of oxide of iron. A part is reduced back into the bath. Then follows a slight oxidation reaching a maximum in the tenth minute. It is again reduced back into the bath,

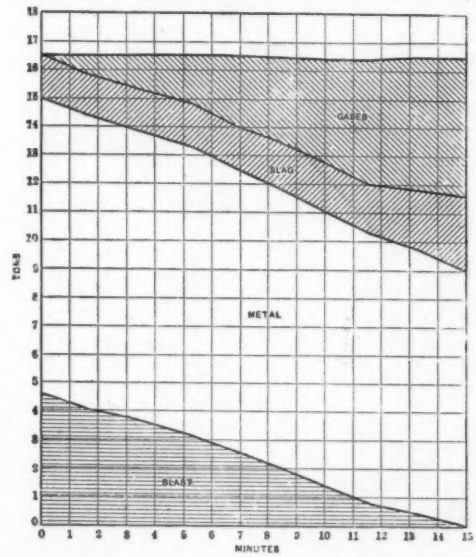


FIG. 2.—BALANCE OF MATERIALS ON CHARGE NO. 1.

from which, in the last 2 minutes, it is almost completely oxidised. The slags show more plainly than the metal the extraordinary part played by the manganese. In the third to the fifth minute its oxidation reaches a maximum whereby, in conjunction with the silicon oxidised at this time, the temperature of the bath is increased considerably. Now carbon reduces metallic manganese back into the bath. Through the progressive oxidation of the carbon the temperature of the bath sinks again, so that the blast again attacks the manganese, thereby increasing the oxide of manganese contents of the slag.

The manganese plays, therefore, the as yet unknown part of heat accumulator for the process. It burns at first and supplies, at this stage of the process, a great part of the necessary heat, whereby the temperature of the bath is considerably raised and is then reduced, and to some extent re-enters the bath. The procedure is united with a deficit of heat.

The silica contents of both charges show two maxima corresponding exactly with the oxide of manganese. It is very probable that the silicon plays a similar part to the manganese, which could be proved if the tests were taken at the right moment.

The course of the oxide of iron is very interesting and instructive. In charge No. 1 the iron is oxidised up to the third minute, then reduced and enters the bath. From the fifth to the eighth minute it remains

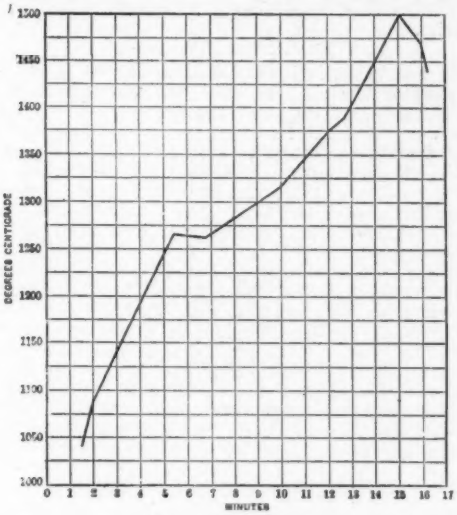


FIG. 3.—TEMPERATURE ESTIMATIONS OF BASIC BESSEMER FLAME.

constant at about 3 per cent., increasing in the tenth minute to 4½ per cent. Here is seen a slight reduction by means of the phosphorus. From the twelfth to the fifteenth minute it increases from 4 to 25 per cent. It also clearly shows in this heat that, like the manganese, the iron is oxidised and furnishes heat.

Metallographic Examination.

Corresponding to the change in composition, the structure of the metal also changes. This was followed by examining most of the metal tests from the two heats.

The pig-iron shows three constituents: Cementite in needles a pearlitic constituent, etching dark with dilute nitric acid and occurring in rounded areas, and a ternary eutectic of ferrite, cementite and phosphide of iron, which is grey when etched with dilute nitric. Previous work of one of the writers had shown it to consist of about 2 per cent. carbon, 6.7 per cent. phosphorus, and 91.3 per cent. iron.

In order to be sure in what condition the sulphur existed in a manganese free pig-iron, a sample was prepared containing 0.405 per cent. sulphur and 3.65 per cent. carbon. On examination the whole

mass showed abundant well formed crystals, appearing grey to greyish blue after etching with picric acid. They are seen most plainly when surrounded by clear cementite. The pig-iron of charge No. 1 shows similar crystals, which are rich in sulphur, as proven by the Baumann test. They are evidently the first to form, as shown by their definite shape.

With the gradual removal of the carbon from the bath there is left a material which should contain chiefly iron and phosphorus. It should, therefore, according to Stead, hold up to 1.7 per cent. phosphorus in solid solution. Test No. 6 of charge No. 1, with 0.094 per cent. carbon and 1.4 per cent. phosphorus ought, therefore, to give a small amount of pearlite and no phosphide eutectic. On the contrary, it showed a non-homogeneous material, one part rich, the other poor in phosphorus.

With relation to the sulphur, the carbon-free, but yet phosphorus-holding, iron crystallises before the sulphur compound, which is, therefore, found between the crystals.

The finished steel shows, as usual, pearlite and ferrite.

Balance of Materials.

In text-books it is only possible to find statements concerning the changes which the materials undergo in the different stages of the process. Nowhere are the weights of the iron and the impurities given for any definite period. The authors of this paper now make the attempt to calculate from the tables the actual weights of all the materials at the different time intervals of the blow. The weights of the bath, the iron and other constituents are given in the original paper.

These results allow one to give the amounts of the blast necessary at the different times for the oxidation of the impurities and the iron. It must be remembered, however, that the moisture in the air and lime furnishes oxygen through decomposition. This may be calculated from the hydrogen in the gases. On the other hand, not all the oxygen is used, which again is found out from the gases. On this account it was necessary to obtain the analyses of the converter gases.

Composition of Converter Gases.

Samples were secured from five heats and average results obtained. The average compositions of the gases are given in Table V., and shown graphically in Fig. 1.

TABLE V.—*Average Analysis of Converter Gases.*

Blowing time. Minutes.	Nitrogen.	Carbon monoxide.	Carbon dioxide.	Oxygen.	Hydrogen.
1¼	80.53	8.71	10.53	0.075	0.155
2	77.12	12.17	10.55	0.083	0.134
3¼	75.32	15.84	8.64	0.125	0.119
5¼	60.48	24.92	5.48	0.006	0.143
5¾	68.56	25 90	5.38	0.000	0.106
6?	65.68	29.28	4.94	0.000	0 110
8¼	64.14	30.64	5 04	0.089	0.112
8¾	64.08	30.92	4.78	0.107	0.111
10	61.86	31.46	3.46	0.076	0.123
11¾	67.30	29.72	2.74	0 046	0.141
12¼	73.26	23.92	2.56	0.031	0.151
13¼	85.92	11.96	1.98	0.008	0.171
13¾	92.12	6.18	1.60	0.000	0.173
14¼	95.60	3.10	1.16	0.000	0.184
15	95 02	2.77	1.03	0.000	0 183
16	96.55	2.40	0.65	0.000	0.196
16¼	97 40	2.00	0 33	0.000	0.203

Then follow calculations, the results being given in tabular form, of the weights of the different constituents of the converter gases of the two charges. The total weights are:—

	Charge No. 1. Lbs.	Charge No. 2. Lbs.
Nitrogen	7,723	9,096
Hydrogen	15	17
Carbon monoxide	2 800	2,965
Carbon dioxide	538	919

The formation of a balance-sheet of materials is now possible without great difficulty from the different tables. It is not shown in tabular form because of the enormous number of figures, but is given for charge No. 1 diagrammatically in Fig. 2.

The co-ordinates are time in minutes and material in tons (metric tons of 2,204 lbs.). It is assumed that at the beginning of the process the total amount of blast is supplied for the carrying out of the process. As the process continues, less and less blast is necessary, corresponding to an increase in the amount of gases produced. With this charge an original amount of air of 4,596 tons produces a total weight of gases of 4,888 tons.

The lime addition is 1.43 tons, while the slag at the end of the process reaches 2.63 tons. It must be remembered that the lime contains 14 per cent. carbonic acid and water, so the amount of slag-forming constituents through the oxidation of the impurities has more than doubled. The metal has decreased from 10.48 to 9 tons, corresponding to a loss of 14 per cent.

The Heat Economy of the Process.

Next was undertaken the task of finding the amounts of heat stored up in the liquid pig-iron and furnished by the oxidation of the impurities. The specific heats and the latent heats are very imperfectly known. They were estimated directly by observing the increase of temperature of a known amount of water when fluid material was added. The tests gave for pig-iron 277 calories, for steel 336, and for slag 536, these figures representing the heat necessary to raise the temperature of the material and also to smelt it.

A Wanner optical pyrometer was used for all temperature measurements, after being carefully checked with a Le Chatelier, which latter was suitably protected.

The average results of the temperature readings of the flame of seven heats are given in Table VI., and shown graphically in Fig. 3.

TABLE VI.—*Average Temperature of Flame.*

Blowing time. Minutes.	Temperature. Degrees C.	Blowing time. Minutes.	Temperature Degrees C.
1¼	1,041	11¾	1,369
2	1,093	12¼	1,389
3¼	1,155	13¼	1,412
5¼	1,251	13¾	1,438
5¾	1,263	14¼	1,475
6¾	1,290	15	1,459
8¼	1,287	16	1,467
8¾	1,291	16¼	1,437
10	1,319		

In the first 5 minutes there is an increase in temperature of about 200 degrees C., and it is to be supposed that the temperature of the metal increases in a similar way. Then comes a period in which the excess of heat is so small that the carrying out of the process would be in question, were it not for the heat stored up in the bath. This dangerous condition may last more than a minute. The excess of heat then begins to increase, reaching a maximum in the case of charge No. 2, with the twelfth minute.

The finished steel, after the addition of spiegel, etc., is on the average 1,552 degrees C. The bath is about 50 degrees C. hotter at any stage than the flame shows, and the slag about 25 degrees C. hotter still. The temperature of the pig-iron is 1,262 degrees C.

From the data now obtained tables are constructed showing the heat relations of the different parts of the process, but they are too large to reproduce.

In charge No. 1 the pig-iron brings in 43 per cent. of the heat, the remaining 57 per cent. being supplied by the oxidation of the constituents of the

bath. Of this total heat 24 per cent. is carried away by the gases, and is also used to decompose the moisture; 20 per cent. goes to the heating of the lime, and is carried away by the slag; 8 per cent. is lost by radiation, and the remaining 48 per cent. remains in the steel.

With the other heat the results are slightly different. Thirty-eight per cent. is brought in with the pig-iron and 62 per cent. supplied by oxidation of the impurities. Twenty-five per cent. is carried away by the gases, 21 per cent. goes to the lime and the slag, 1 per cent. to melting the scrap, 11 per cent. lost through radiation and 42 per cent. remains in the steel.

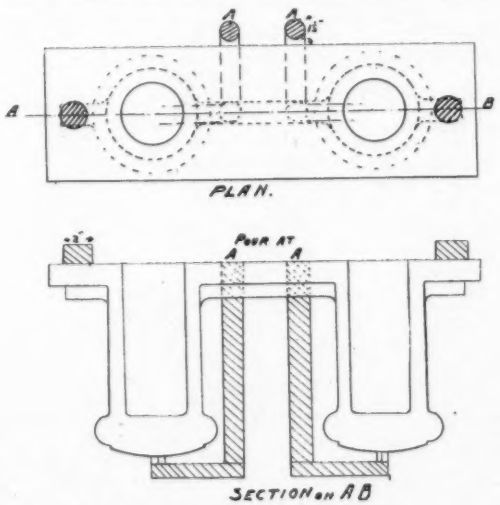
It now becomes possible to inquire what influence dry air, hot air or air enriched with oxygen would have on the process. The conclusion is reached that they would not remove the unfavourable points, thus insuring its future. Dry air would have no great influence on the heat economy of the process, but it would undoubtedly lead to an improved product, because of no opportunity being given the metal to absorb hydrogen. The use of blast enriched with oxygen is not a profitable undertaking. With the same amount of blast it would finish the heat a little more quickly. This small advantage is more than overbalanced because the heat would be so hot toward the end of the process that it would be impossible to remove the last traces of phosphorus without the sacrifice of a large amount of iron. The use of hot blast would give similar results to that of blast enriched with oxygen. It would be cheaper and could be advantageously used to increase the temperature at the beginning of the process if the silicon were low in percentage.

The greatest excess of heat is brought about during the separation of the phosphorus. It is the reason for the great oxidation of iron. This is necessary for the carrying out of the process, but it would be much better if it came at the beginning, as in the ordinary Bessemer process. Some advantage is taken of this excess of heat by adding scrap or lime briquettes, as in the Flohr process, but it still remains the chief objection of the basic Bessemer process.

The paper closes with a brief comparison of this process and the basic open-hearth, to the advantage of the latter.

Casting Bollards in Green-Sand Moulds.

The following instructions relate to the method of moulding and casting bollards in green sand. Place the pattern on a level board or top part, then put on the mid part; put in two gate-pins as shown in the illustration, and ram to point C. Then make the parting or joint. By having the mid part made so that the bars are within 1 in. of the pattern around



CASTING BOLLARDS IN GREEN SAND.

the loose caps, a safer and quicker job will be made than by working with a grating. Having made the joint, next place on the drag or bottom part, and ram it up; then prick it and turn over the box on a level bed. Make the joint and put on the top part, place the risers in position, and ram it up. Strike off level and give it a good prick so that it will let the air off and keep it from scabing. Take off the top part, draw out the pattern, and finish the mid part; then lift it off and finish the bottom part by black-washing and skin-drying the caps. The reason for doing so is that it gives nice clean castings, as they are cast from the bottom, as shown. Then place the cores in position, lower on the mid part and top part, and make ready to cast.

The chief essentials in green-sand moulding are to ram well and prick well, and to have a good facing sand. The writer recommends the following mixture for heavy green-sand work: One barrowload of rock sand, two of yellow sand, one of black sand, and nine shovels of dry coal dust.

DURING the last six months the M.A.N. (Maschinenfabrik Augsburg-Nurnberg A.G.), 219, Caxton House, Westminster, S.W., have received orders for 21 Nuremberg gas engines, of, altogether, 44,355 b.h.p., *i.e.*, an average of 2,112 b.h.p. per engine, thus bringing the total number of gas engines of this firm delivered or on order to 279, of a total of 374,190 b.h.p.

IT is stated that the works at Darlington belonging to Sir Theodore Fry & Company, Limited, have been disposed of as a going concern to Mr. R. O. Davies, the managing director of the company, and a new company is to be formed to carry them on. The works are old-established, and until recently were conducted very successfully. It will be some time before the works will be ready to start again on full time.

THE Model Engineering Exhibition, which opens at the Royal Horticultural Hall, Westminster, S.W., on Friday, October 15 will contain some exceptionally interesting exhibits. There will be a number of model aeroplanes on view, while working model steam and electric railways, light machine tools, model motor boats, a model engineer's workshop in operation, and a working demonstration of wireless telegraphy are some of the numerous attractions which will be presented. In the competitions for engineering and electrical model making over a hundred entries have been received. The Exhibition will remain open for eight days, closing on Saturday, October 23.

Correspondence.

The Application of "Rule-of-Thumb" and Science in the Foundry.

To the Editor of the FOUNDRY TRADE JOURNAL.

SIR,—In September's "Notes and Comments" the references to the above paper are to me somewhat perplexing, and after carefully reading them I ask myself whether I committed an offence in quoting the extract, "The finest rule-of-thumb men, etc.," which, in my opinion, was a sweeping statement. I hope the paper is not so obscure that its true purpose is altogether hidden. The fact must be apparent that there exists a gap between a large number of experienced foundrymen and technical men; and to my mind some writers, perhaps unintentionally, are widening that gap by referring to foundrymen of long and tried experience, and for whom I have a profound regard, as "rule-of-thumb men." This they naturally resent. It is useless to question the original meaning of the term, we must take it in its present accepted sense, which is offensive. For obvious reasons these men are just the kind we want in the British Foundrymen's Association, but we shall never attain that by being offensive. Neither will they appreciate the objects of the Association or the FOUNDRY TRADE JOURNAL, both of which are educational mediums, so long as that attitude is shown.

Whether the form of preparation of my paper was unusual or not, the motive was to close the gap above mentioned. As I endeavoured to show, and as I think you will agree, so-called foundry rule-of-thumb is more or less scientific, whether it is known as that or not. The point of the paper has been entirely lost if it has been possible to read it without realising that it was the result of serious thought, experiment, and the study of metallurgical, chemical, technical and practical matters. These I endeavoured to combine as science. I venture to think, too, that I referred to certain matters in foundry practice that are seldom heard of by some technical men. It is true that one friend did remark that I had not given the paper the right title, and that it should have been "Practical Science in the Foundry." However, it has been gratifying to receive from various quarters assurances that this and previous papers I have prepared, should do much to remove the differences which exist between theoretical and practical men. I trust this communication may somewhat alter the aspect.

Yours, etc.,

SIDNEY G. SMITH.

[We regret that we have created the impression of depreciating the merit of Mr. Smith's paper, for it was certainly a valuable one, though at the same time we think the title suggested above would have been a better one. What we wished to draw attention to was the mistake which is often made in assuming that the "scientific" worker is necessarily without the practical experience of the so-called "rule-of-thumb men." The ideal scientific worker is the one who applies a knowledge of scientific facts to his accumulated experience. We, further, certainly did not wish to apply the term "rule-of-thumb men" in an offensive manner, but merely in the way it is frequently used to denote a worker skilled by practical experience alone—but nevertheless skilled. We are heartily at one with the author of the paper in his desire to close the gap between this man and the one who has a scientific knowledge of his work; this amalgamation is very necessary. But in elevating the one, care must be taken not to appear to detract from the merits of scientific and laboratory knowledge.—THE EDITOR, F.T.J.]

Cast Iron Planing Tools.

To the Editor of the FOUNDRY TRADE JOURNAL.

SIR,—The article appearing in your recent issue on "Cast Iron Turning Tools" might very usefully be supplemented by the experiences that came my way concerning tools of this description some three years ago. I may say the initiation of the experiments arose out of a friendly bit of chaff between the foreman fitter and myself. The former paid a visit to the foundry one day, his woe-begotten countenance bespeaking mountains of trouble. "If you will make your castings as hard as chilled steel you might have the condescension to make some tools that would at least scratch them!" was the fitter's dismal lament. A hasty assertion that I could do this resulted in experiments on the matter, though unlike the tools mentioned in your paper, mine were made, not of square section, but rectangular, inasmuch as they were specifically wanted for a planing job. They measured 15 in. in length, 3 in. in width, and were 1½ in. in thickness, with the usual rounded nose. Unlike those other tools, which were chilled for a distance of 1¾ in. from the cutting edge, mine were only chilled about ½-in. from the point. This was perhaps an advantage, since the less area of surface to be chilled the more thorough would be the process of chilling. A clearance angle of about 3 degrees was formed in the chill which gave to the tool sufficient front rake without detracting from its strength. The first test for this tool was perhaps a fairly severe one, inasmuch as the job to be machined was a facing on a casting some 6 ft. in length by 4 in. in width. Holes 1 in. square, pitched about 6 in. apart, occurred throughout the length of the facing. Moreover, I knew the skin of the casting had been pretty freely watered by an ignorant moulder.

The operator's sarcastic grin as he bolted up the tool certainly made my friend and myself feel a trifle nervous, but, contrary to our triple expectations, the nose of the tool held good. We waited expectantly for the smash that did not come. "Wait until the cut reaches the holes," was the foreman fitter's sceptical comment, but the tool passed over the holes without any apparent difficulty, and, moreover, with but little loss of its cutting edge, as far as we could observe.

When the cut was through we considered it advisable to grind the tool. Now here appears the only drawback to be found with chilled cast-iron tools. The extreme degree of hardness necessary to ensure clean cutting does not seem to permeate the metal to any great depth, at any rate, not to permit of grinding. The tool at the second test proved much less able to stand up to the work, even though the skin was off; so much so, in fact, that it had to be discarded. One thing this particular test clearly and abundantly demonstrated—that was the superiority of chilled cast iron over the best air-hardened steel for a first roughing cut, especially when the hardness of the metal to be cut is due to water chilling on the skin. Of course, it must be clearly understood that this statement is made with a deal of reservation. In fact, it would be best to say the statement referred to only applies to the particular test that came under the writer's observation, for to state broadly and unreservedly that cast-iron chilled tools are superior to steel would be ridiculous. What I do maintain, however, is, that there might crop up cases, perhaps similar to the one I have mentioned, where a properly chilled cast-iron tool would get over many a difficulty as regards chilled faces on castings. More particularly does this apply in a small jobbing shop where the facilities are none of the best and high-class, air-hardened steel all but unknown.

Yours, etc.,

W. J. JACKSON.

Inventions.

Applications for Patents.

An asterisk indicates that a complete specification accompanies the application. When inventions are communicated the names of the communicators are in brackets.

19,611.*Apparatus for automatically preparing old and new moulding sand. Vereinigte Schmirgel- und Maschinen-Fabriken Act.-Ges. vormals S. Oppenheimer & Company und Schlesinger & Company.

19,648. Expansion joint for furnace flues. C. Walke, 5, John Dalton Street, Manchester.

19,764.*Process and apparatus for the production of metals. F. C. W. Timm.

19,020.*Method of lining foundry utensils and appliances. P. H. G. Durville.

19,124. Regenerative gas furnaces for melting steel. J. Izzett, 96, Buchanan Street, Glasgow.

19,276. Apparatus for preparing casting moulds especially applicable for moulds for casting turbine cylinders, etc. R. Oliver.

20,027.*Sand dryers. C. S. French.

20,040.*Casting metals. (European Brake Shoe Company, United States.)

20,293.*Crucible furnaces. J. W. Chenhall, Broad Sanctuary Chambers, Westminster, London.

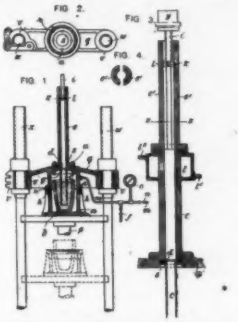
20,372. Manufacture of castings. Hobbes, Limited, and H. Jewson.

20,449. Faucet-end for wrought-iron, steel, and other pipes. A. Eadie and J. Tannahill, 121, West George Street, Glasgow.

21,255. Melting-furnaces and crucibles, and for forging, annealing ovens, etc. C. E. Hall, 87, Fargate, Sheffield.

Abstracts of British Patent Specifications recently accepted.

11,423 (1909). *Apparatus for Casting Metals.* The Broughton Copper Company, Limited, Broughton Copper Works, Salford, and F. Tomlinson.—The invention relates to the method of casting metals having melting points of over 1,000 degrees Fahr., such as copper, iron, steel, brass, and other metals and alloys, by conveying the molten metal from a container to a mould by the direct action of gaseous fluid pressure upon the surface of the molten metal, as described in Specification No. 13,593 of 1908. The present invention consists of a convenient arrangement of apparatus for carrying the method of casting such metals into practical effect under ordinary conditions of working, say, for example, when casting billets, rods, tubes, etc. Fig. 1 is a sectional elevation, Fig. 2 is a plan of the crosshead Fig. 1, and Fig. 3 is a sectional elevation illustrating the application of a fluid resistance to the upward flow of molten metal in the mould, and of a simple form of cooler near the upper end of the mould. This view also shows an arrangement of guides for the extension of the mould. Fig. 4 is a sectional plan of the guides, taken on the plane of the line Z—Z, Fig. 3. The container *a* is mounted on a hydraulic ram by means of which it can be readily raised and lowered. The mould *e* is supported by a crosshead *q* to which it is bolted. This crosshead also forms a cover to the container, and its underside is arranged to form a pressure-tight joint *h* with the top of the container, when the latter is forced up to its highest position to the hydraulic ram *p*. The plan, Fig. 2, of the underside of the crosshead shows the rib or annular projection *r*, which is utilised to form the joint *h*. When the ram *p* is in the lower position indicated by dotted lines in Fig. 1, a crucible *b* containing the molten metal to be cast is introduced into the container. The ram is then set in motion lifting the container and its contents to the top position, shown in full lines, and making a suitable pressure-tight joint at *h*. The gaseous fluid pressure is then admitted into the container through the pipe *m*, and regulated by the valve *n*, and by this means the molten metal is thus forced up and through the conduit *c*. This conduit is previously heated in order to prevent it prematurely chilling the molten metal, and further heat may be applied subsequently to any part of the apparatus wherever desirable or advantageous for the efficient working of the operation. As the metal rises in the

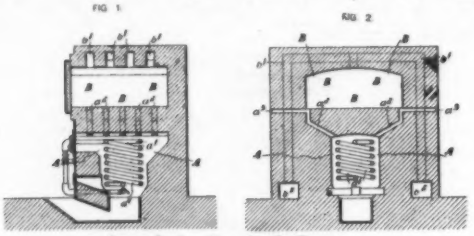


Broughton Copper Company's Apparatus for Casting Metals.

mould *e*, the gas or air previously filling the mould escapes by the vent *l* in the plug *k*; a little molten metal follows into the vent *l*, but chills and sets solid, thus automatically sealing up the vent. If the plug *k* is held in position as shown in Fig. 1, the gaseous fluid pressure on the surface of the molten metal in the container is increased to the necessary degree to sustain and compress the metal in the mould *e* until the metal has solidified. The pressure in the container is then relieved by opening the relief valve *f*, and the container with its contents is lowered to its bottom position by means of the ram *p*; the bolts *u* are then loosened and the casting is forced out of the mould by aid of the piston rod *i* fixed to the plug *k*. In Fig. 3 is shown that the plug *k* has a further function other than to press out the finished castings. This plug is sometimes used as an adjustable resistance to the upward flow of the molten metal in the mould. For example, when casting billets, rods, or tubes, the casting as it solidifies is forced upwards and out of the top of the mould into the guides e^1, which are securely fixed to the top of the mould. The rate of movement of the cast metal in the mould *e*, and as it ascends into the guides e^1, is controlled by the regulated resistance of the plug, so that the progress of the cast metal under the gaseous fluid pressure in the container may be either retarded, advanced or rendered stationary as desired.

19,018 (1908). *Gas-fired Furnaces.* P. G. Barnsley, of John Barnsley & Sons, Netherton, near Dudley, engineers and ironfounders.—The invention comprises the combination of several known features, and consists in a producer immediately beneath the furnace with gas flues from the producer to the side edges of the base of the furnace, and with air inlets led to these points, steam raising means in or about the producer with a water feed and an injector for blowing steam and air into the producer. Fig. 1 is a longitudinal vertical section of a furnace carried out in accordance with the invention; Fig. 2 is a lateral vertical section thereof. This example shows the furnace in its preferred construction with the producer A which is of ordinary form directly beneath the furnace B, so that

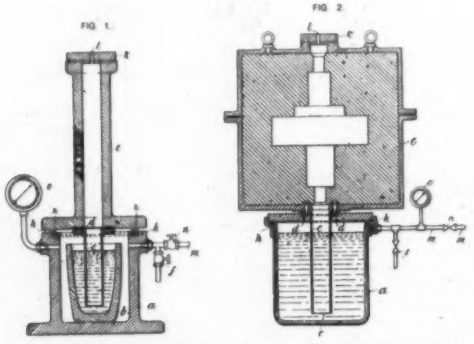
the top of the producer and the floor of the furnace become one and the same. The producer A has the usual provisions for charging and for blowing or feeding with air and steam, but the inventor further provides it with a coil or battery of pipes such as a^1 in the interior running around the walls which is supplied with water and serves for supplying steam for the usual steam injector so that a separate steam generator is not a necessity. From the upper part of the producer A, gas flues are provided which in this example are shown inclining upwards as at a^2 entering the furnace B at the sides of the floor. At the points where these gas flues a^2 pass up through the floor of the furnace, are arranged air inlets a^3 passing straight



Barnsley's Gas-fired Furnace.

into the flues from the outside of the furnace, so that the gases distilled off from fuel in the producer A are burnt at their entry into the furnace. The products of combustion from the furnace may be carried away by a common flue to a stack and a damper or dampers in the flue by constricting the outlet for the gases may regulate the air drawn into the furnace through the inlets a^3. If desired to attain high temperatures, the air may be heated prior to passing into the furnace by being passed around the waste gas flues or around the furnace or producer walls or otherwise as found convenient.

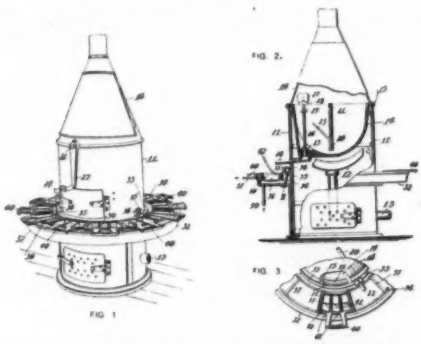
13,593 (1908). *Method of and Means for Casting Metals.* The Broughton Copper Company, Limited, Broughton Copper Works, Salford, and F. Tomlinson.—



Apparatus for Casting Metals, by the Broughton Copper Company, Limited.

A suitable closed vessel is employed to contain metal having a melting point of over 1,000 degrees F.; this container is connected to a suitable mould by a pipe, one end of this is suitably connected to the mould, and the other end projects downward into a well under the surface of the molten metal, so that when air or gas under pressure is admitted to the container this gaseous fluid pressure acting upon the surface of the molten metal forces it from the container through the conduit unobstructed by any form of valve into the mould. Fig. 1 represents a sectional elevation of one of the simplest forms of apparatus; Fig. 2 is a sectional elevation showing the container made in the form of a ladle.

14,959 (1908). *Apparatus for Melting Metal, Casting it into Ingots, and Cooling the Latter.* R. T. Johnston, Park Avenue, Scotch Plains, County of Union, New Jersey, U.S.A.—Figure 1 is a perspective view of an apparatus constructed in accordance with the principles of this invention; Figure 2 is a central vertical sectional view of the same showing certain parts in elevation; and Figure 3 is a plan of a portion of the mould supporting, carrying, and cooling device, showing a part of the furnace. The invention is illustrated as embodied in a form in which the furnace proper preferably consists of a metal shell 11 lined with asbestos. The furnace may be designed to operate with any desired kind of fuel, but it is shown as being provided with a gas burner 12 supplied by a pipe 13 entering the lower portion of the furnace. Supported at the top of the shell 11 is a melting pot 14, having a horizontal flange 15 resting on top of the shell 11. On this flange rests a hood 16, which is connected with a flue. It will be seen that the fumes from the molten metal may be discharged directly into the hood; and as a part of the flange 15 is omitted or cut away at 18, the products of combustion from the burner are also discharged into this hood. By this construction a simplification is obtained, as a single outlet for the fumes, products of combustion, etc., both from the melting pot and from the flame, is provided for. When the furnace is designed to remelt metal, it is desirable to provide means for stirring the same, which is shown

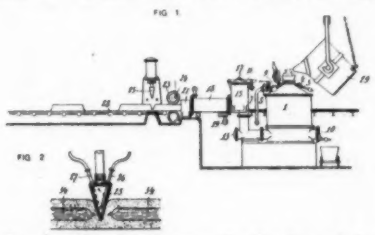


Johnston's Apparatus for Melting Metal, Casting it into Ingots, and Cooling the Same.

herein in the form of a stirrer 20, mounted to swing on end trunnions 21, which do not extend across the melting pot 14, and therefore do not interfere with charging it. One of the trunnions is provided with a handle 22 on the outside of the furnace. The stirrer is preferably of crescent shape, so that it will sweep along substantially the entire bottom of the melting pot. The melting pot is provided with a spout 24 through which its contents may be discharged, this being controlled in the present instance by a valve 25 having a valve stem 26 normally held down to its seat by any desired means, as a weight 27, the valve stem being guided by a bracket 28. In the present case the valve stem 26 is provided with a collar 29 adapted to be engaged by the projection 23, when the stirring device is operated to its extreme position in one direction. This not only stirs the metal, but it opens the valve and allows the metal to be discharged through the spout 24 into moulds 30. The upward motion of this collar 29 is limited by the bracket 28, and as the collar is adjustable along the valve stem, its position regulates the distance which the valve can be opened. The moulds 30 are detachably supported in the following manner. On the furnace shell 11 are a plurality of outwardly extending brackets 31 constituting a support for an annular stationary trough 32. This trough contains water, and the top edge next the furnace is widened by a ledge 33. With this construction, the moulds remain in water practically all the

time, and water can be circulated through the trough through inlets 50 and outlets 51 which, being stationary, do not require any packing of joints in order to keep them tight. Within the trough is located a spider 34 which, when the furnace is circular, will be of similar form, and which corresponds in shape with the trough as it is contained therein. This spider has upwardly projecting arms 35 on which are mounted rollers 36 rolling on the ledge 33, and is of such form as to support the moulds 30 and carry them around the furnace.

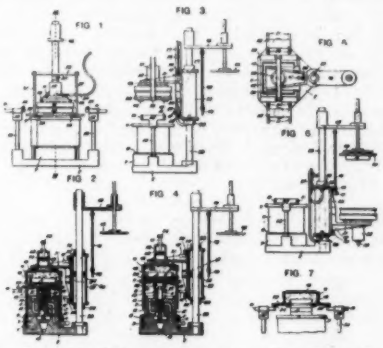
19,162 (1908). *Apparatus for the Continuous Production of Ingots.* M. Douteur, 19, rue de l'Université, Liège, Belgium.—In order to absolutely dispose of the disadvantages hitherto arising from the action of the molten charge on the mould, the invention substantially consists in placing the ingot mould with its observation chamber as near as possible in or near or above the plane of the upper level of the molten steel mass in the casting vessel, and in placing the latter in communication with the ingot mould by means of an ascending conduit into which molten steel is forced by air or gas pressure acting on the contents of the casting vessel. With this arrangement the mould can be rapidly isolated from the casting vessel in case of danger or other necessity, for example by opening a cock or valve, without operating, closing, or like devices arranged in the conduit between the mould and casting vessel, such devices being liable to be inoperative when required, owing to their exposure to the action of molten steel. To obviate the usual dis-



Apparatus for the Continuous Production of Ingots, by Douteur.

advantages arising from the cutting of imperfectly solidified ingots the invention utilises for the operation in question a hammer having a continuously cooled, hollow, cutting member or part, which effects a supplementary cooling of the steel, when it enters the same, sufficient to produce the solidification of any metal which may have remained liquid at the core. In order to provide a further preventive of inconvenience and risk arising from insufficient cooling of the ingot mould, the latter is constructed in the form of a coiled tube of strong material, for example steel, and is more particularly distinguished from the ingot moulds heretofore known, by the fact that it traverses a mass of metal fusible at a comparatively low temperature, so that the melting of this metal affords an indication that the ingot is insufficiently cooled, and accidents or loss are thus avoided. Figure 1 is an elevation of plant for the manufacture and automatic manipulation of ingots; Figure 2 is a separate sectional view of the cutting member of the hammer used for cutting the ingots.

17,894 (1908). *Foundry Moulding Apparatus.* H. L. Demmler, Kewanee, County of Henry, Illinois, U.S.A.—This invention relates to moulding apparatus of the class wherein mechanism is provided for vibrating the mould box to pack the sand around the pattern. The principal object is to provide means for simultaneously vibrating the mould box, together with improved means for pressing the sand into the same. Figure 1 is a view of the apparatus in front elevation; Figure 2 is a vertical sectional view indicated by the line II. II. of Figure 1, showing the flask in position for operation by the vibrating packing mechanism; Figure 3 is a view of the apparatus in side elevation showing the flask raised above the vibrating mechanism; Figure 4 is a sectional view similar to Figure 2, illustrating the vibrating mechanism at its upper position; Figure 5 is a plan view of Figure 4; Figure 6 is a view of the apparatus in side elevation showing the flask-supporting cross head reversed; Figure 7 is a detail sectional view illustrating the stripping plate supports. In the annexed cuts, 2 represents the base of the machine, having a centrally extending base 3, with which is incorporated the inlet port 4 and a preferably separate pressure abutment 5 embodying a valve chamber, the base 3 being surrounded by bearing abutments 6 consisting conveniently of a series of wooden blocks clamped within a surrounding ring 7, for the purpose of absorbing the shock of contact of the vibrating cylinder. 8 represents the vibrating cylinder having at its upper portion the transverse head or platen 9, and between the head and the upper end of pressure abutment 5 is interposed a surrounding extended contact terminal 10 provided with a cushioning spring 11, bearing against the terminal 10 and the end of the pressure abutment respectively, the purpose of which is to absorb the initial shock of impact of the platen on downward travel. 42 is a pressure board adapted to bear against the sand at the upper side of the flask when in the pressing position (Figure 4), and between the board and the cross head, and between the stripping plate 39, and platen 9, are preferably inserted bearing strips, 43, 44, although these may be dispensed



Foundry Moulding Apparatus, by Demmler.

with if desired. In operative position, as shown in Figures 2 and 4, the cross head 31 is swung around upon standard 23, and clamped to the flask and stripping plate by bars 37, pressure being exerted beneath piston 24, to lower the cylinder 25, and hold the flask downwardly against the platen. Pressure being introduced through port 4, when the platen is lowered (as in Figure 2), results in upward movement of the platen against the opposing pressure of the cross head and causing its partial upward travel, incidentally compressing the fluid below the piston 24. Upward travel of the platen, and resulting upward travel of valve 14, results in cutting off the supply and opening the exhaust port 16, immediately reducing the pressure beneath the platen, whereupon it will fall and open the valve for a new supply; and such intermittent vibration and packing of the sand will continue as long as the pressure is maintained in port 4. For the purpose of removing the pattern from the flask the mechanism provides means whereby the cylinder 25 and cross head 31 may be raised from contact with the platen, as in Figure 3, the stripping plate being maintained clamped, and in such position is swung around upon standard 23 to a point beneath a pattern support 45. This support depends downwardly below an arm 46, with which it is connected in any suitable manner, the arm extending outwardly from the upper portion of standard 23, and is adapted to engage and hold the stripping plate 39 and pattern A by any suitable clamping means.

Trade Talk.

MR. C. THOMAS, metal manufacturer, of Birmingham and Moseley, has been adjudged bankrupt.

THE STEEL COMPANY OF SCOTLAND, LIMITED, are reconstructing in part the steel melting department at their Blochairn Works.

THE BRITISH GRIFFIN CHILLED IRON AND STEEL COMPANY, LIMITED, have removed their London offices to 81, Cannon Street, E.C.

MESSRS. W. ROWLANDSON and T. OWEN, engineers, etc., Liverpool, trading under the style of W. Rowlandson & Company, have dissolved partnership.

MESSRS. D. MITCHELL & COMPANY, makers of lathes and high-speed drilling machines, Keighley, have recently built a new fitting shop and show-room, 180 ft. long by 30 ft. wide.

J. B. PETTER & SONS, LIMITED, oil engine makers, are making considerable extensions to their works at Yeovil, which include a large foundry equipped with the latest machinery, etc.

A DISSOLUTION of partnership is notified in connection with Messrs. W. McLachlan and E. K. Green, engineers, etc., Armley, Leeds, who traded under the style of W. McLachlan & Company.

STEEL, PEECH & TOZER, LIMITED, of the Phœnix Special Steel Works, Ickles, Rotherham, Yorkshire, are about to instal a mixed pressure turbine and electric generator of 1,500 kw. capacity, which will take the exhaust steam from the rail mill engine. When the installation is completed the present central generating station will act as a standby, and only be put into operation when the mill is standing.

IT will be remembered that this year and for the next four years the Council of the Society of Engineers have instituted a prize for the best essay on "How to Improve the Status of Engineers and Engineering, with Special Reference to Consulting Engineers." The result of this year's competition is that Mr. G. Aflan Thomas has been awarded the prize, and he read his essay at the meeting of the Society held on October 4 at Caxton Hall, Westminster, S.W.

WILLANS & ROBINSON, LIMITED, of the Victoria Works, Rugby, after prolonged experiments, are placing on the market a steam turbine of the Impulse type, intended to meet those cases in which a speed of as high as 3,000 r.p.m, is admissible. This will provide for a capacity up to 1,500 k.w. The turbine has been designed with a view to efficiency as well as simplicity. The rotating element consists of two wheels only, but the economy realised compares favourably with that of other turbines. In future, therefore, Willans & Robinson, Limited, will be in a position to supply turbines either of the Parsons or of the Impulse type.

As a result of the better feeling in the iron trade in North-East Derbyshire, several firms have booked orders for some months ahead. The works of the Renishaw Iron Company, Limited, and the Staveley Iron and Coal Company, Limited, are now fairly busy, and the latter company have relighted a blast furnace damped down a year ago, while they are also building a new furnace. Longer hours, too, are being worked at the Sheepbridge Coal and Iron Company's foundries and steel works. As an outcome of this, the Midland Railway Company have returned to full time at several of the locomotive departments near Chesterfield, and have taken on additional hands. Nearly all the Great Central Railway Company's employés in the district are also engaged.

BY an order dated July 28, under Exemption 3, of the Regulations for the Generation, Transformation, Distribution, and Use of Electrical Energy in Premises under the Factory and Workshop Acts, 1901 and 1907, the Home Secretary directs that the following conditions shall be deemed adequate to prevent danger:—In rooms, other than electrical stations, in which no electrical energy is used except at low pressure, nor for any purpose other than lighting by means of incandescent lamps, and the floor is of wood or otherwise insulating; and there is no machinery or other earthed metal with which a person handling any non-earthed lamp, fittings, or any portable lamp is liable to be in contact; and no process rendering the floor wet is carried on; and no live conductor is normally exposed so that it may be touched.

WE understand that the Parliament of Japan has already voted 1,800,000 yen towards the expenses of the Japan-British Exhibition, which is to be held at Shepherd's Bush next year, and the Government of Formosa and the Local Prefectures have also voted large sums for the Exhibition. The political alliance between the two countries lends increased importance to this Exhibition, which will cement yet more firmly the friendship of the two nations. This is the first exhibition of Japanese products ever held in Europe, and therefore cannot fail to arouse interest. The progress which Japan has made amongst the great powers will be demonstrated by such a display of her products and resources as will indicate not only the position which Japan has already won, but her brilliant prospects in the future. The Japanese Government has already secured a large portion of the existing Exhibition buildings and grounds, and a corresponding proportion of the remaining grounds and palaces has been reserved for a display of the arts, products, and manufactures of the British Empire. The Exhibition will, doubtless, afford Great Britain exceptional opportunities for the maintenance of her unique position in the foreign trade of Japan.

ASHMORE, BENSON PEASE & COMPANY, LIMITED, of Stockton-on-Tees, have been awarded a contract of considerable magnitude in a world-wide competition for the supply, delivery, and erection in Calcutta of riveted steel mains for the water supply of that city. The main lines of pipes will be 6 ft. and 5 ft. internal diameter, with reducing pieces and valves at the various branches which occur at frequent intervals to connect up to the smaller distributing mains. The total length of the main lines will be about 4½ miles; they will pass through the principal thoroughfares of the city, and where necessary will be carried by riveted lattice girder bridges with water-trough bottoms over canals and railways. The bridges which also form part of this important contract will have suitable arrangements providing for expansion and contraction. The total weight will be considerably over 3,000 tons. The whole of the materials in the contract will be of British manufacture. The work has to be completed within two years from receipt of instructions to commence, and as three months of each year is a rainy season during which it is not practicable to continue the work of erection it means that the whole contract must be carried out within 18 months.

THE WAUNTREODA ENGINEERING WORKS AND FOUNDRY, Whitchurch, near Cardiff, were offered for sale by public auction last month. The whole property comprises an area of two acres and a-half, or thereabouts, and is held upon lease for a term of 80 years from December 25, 1862, at an annual ground rent of £30. The buildings consist of machine fitting and erecting shops, with loft over part 187 ft. by 86 ft.; office and stores, 44 ft. 6 in. by 22 ft.; smiths' shop, 10 ft. 9 in. by 21 ft. 6 in.; foundry, 126 ft. 6 in. by 44 ft.; engine house, adjoining foundry, 51 ft. 6 in. by 16 ft. 6 in.; stores and outhouses. There are 285 yards of sidings (570 yards of rail), including points and crossings as laid throughout the works, and also valuable siding accommodation. The plant and machinery were sold in piecemeal, and the following were the principal purchasers:—Mr. W. H. Gould, Barry; Messrs. Mountsford, Phillip & Company, Llantrisant; Messrs. T. Baker & Company, Bute Docks; Mr. D. Evans, Eagle Foundry, Llandaff; Mr. T. J. David, Tondu Foundry; Messrs. Gueret, Limited; Mr. Youlden, Cardiff; Mr. F. Stowe, Bristol; Mr. C. D. Phillips, Newport; Mr. William Lewis, Merthyr; Messrs. Jones & Williams, Rhondda Valley; Mr. T. Gregory, Taff's Well; Mr. G. Lawrence, Caerphilly; Mr. T. Lawrence, Taff's Well; Mr. J. R. James, Whitchurch; and Messrs. T. E. Evans & Company, Cardiff. There was no purchaser for the lease.

New Companies.

J. T. Pickering, Limited.—Capital £1,000 in £1 shares, to carry on the business of hoisting and general engineers, etc.

Carr, Wild & Company, Limited.—Capital £3,000 in £1 shares, to carry on the business of manufacturers of and dealers in finished and unfinished metal blades, etc.

Blomfield Syndicate, Limited.—Capital £2,000 in £1 shares, to adopt an agreement with W. A. Mercer, and to carry on the business of mechanical and general engineers, etc.

Bowker & Brown (1909), Limited.—Capital £2,000 in £1 shares, to carry on the business of manufacturers of machinery, etc. Registered office: 7, Bull's Head Yard, Manchester.

National Steel Foundry, Limited.—Capital £41,250 in 40,000 ordinary shares of £1 each, and 25,000 deferred shares of 1s. each, to carry on the business of iron and steel makers, etc.

Raybould's, Limited.—Capital £2,000 in £1 shares, to carry on the business of contractors, mechanical, constructional, and general engineers, etc. Registered office: Marsh Side, Workington.

Wm. Johnson & Sons (Leeds), Limited.—Capital £10,000 in £1 shares, to take over the business carried on by Wm. Johnson & Sons (Leeds), Limited, at Castle Foundry, Armley, Leeds.

Progress Company (West Hartlepool), Limited.—Capital £1,000 in £1 shares, to carry on the business of engineers, ship repairers, etc. Registered office: Middleton Works, West Hartlepool.

W. H. Micklethwait & Company, Limited.—Capital £25,000 in £1 shares, to adopt an agreement with W. H. Micklethwait, and to carry on the business of iron founders, steel makers, etc.

Clarence Engineering Company, Limited.—Capital £1,000 in £1 shares, to carry on the business of mechanical engineers, etc. Registered office: 3, Cherry Tree Court, Aldersgate Street, E.C.

Hughes & Lancaster, Limited.—Capital £50,000 in £1 shares, to take over the business of engineers, etc., carried on by J. Hughes and C. Lancaster in London, Liverpool, and Acre Fair, as Hughes & Lancaster.

E. A. Gardner & Sons, Limited.—Capital £5,000 in £5 shares (100 preference), to take over the business of engineers and founders carried on by Gardner & Company. Registered office: Brewer Street Works, Brewer Street, Maidstone.

Samuel Pegg & Son, Limited.—Capital £12,000 in £1 shares, to take over the business of engineers and ironfounders, carried on by S. J. Pegg and S. A. Pegg, at Leicester, as Samuel Pegg & Son. Registered office: Alexander Street, Leicester.

Anti-Boiler Explosion Company, Limited.—Capital £120 in £1 shares, to acquire the interest of J. Hopwood and Rachel Thomas in an invention for preventing boiler explosions. Registered office: Lower Forest Foundry, Morriston, Swansea.

Hooper & Edman, Limited.—Capital £20,000 in £1 shares (5,000 preference), to acquire the business of G. A. Edman, of Spring Hill Foundry, Birmingham, and to carry on the business of manufacturers of and dealers in bedsteads, fenders, etc.

F. W. Brackett & Company, Limited.—Capital £5,000 in £1 shares, to carry on the business of iron masters, engineers, etc., and to adopt an agreement with F. W. Brackett and P. Pryce-Brown. Registered office: 4, Broad Street Place, E.C.

Thomas Hall, Limited.—Capital £2,000 in £1 shares, to take over the business of manufacturers of and dealers in springs, joiners' or other tools, etc., carried on by T. Hall at Spring Works, Eldon Street, Sheffield. Registered office: 87, Eldon Street, Sheffield.

Integral Steam Generator Syndicate, Limited.—Capital £21,000 in £1 shares, to acquire certain inventions relating to raising steam in a boiler by means of an internal combustion engine and an air compressor, and to adopt an agreement with A. D. M. Tucker.

Stassano Electro Steel and Furnace Company, Limited.—Capital £1,000 in £1 shares, to acquire the sole right to purchase certain patents relating to Stassano patent furnaces and to carry on the business of steel makers, etc. Registered office: 63, Queen Victoria Street, E.C.

Herbert & Sons, Limited.—Capital £5,000 in £1 shares (3,000 preference), to adopt an agreement with G. Herbert for the acquisition of the business carried on by him at 6-7, West Smithfield, E.C., as Herbert & Sons, and to carry on the business of weighing machine manufacturers, etc.

Worsley Mesnes Ironworks, Limited.—Capital £50,000 in £1 shares, to take over the business of engineers and ironfounders, carried on by T. Melling, J. W. Melling, and S. Melling, at Worsley Mesnes, Wigan, together with certain lands, buildings, and other property belonging thereto.

West Moor Engine Works Company, Limited.—Capital £8,000 in £1 shares, to adopt an agreement between H. R. Lynn and H. E. Lynn of the one part, and F. Lewis of the other part, and to take over the business carried on at Pallion, Durham, as the West Moor Engine Works Company.

Marine Boiler Tube Cleaning Company, Limited.—Capital £2,000 in £1 shares, to acquire the rights for the United Kingdom or abroad in an invention for improvement, relating to ratchet gearing, particularly applicable for driving tube-cleaning apparatus. Registered office: 103, Bath Street, Glasgow.

Paradox Piston Ring Company, Limited.—Capital £3,000 in £1 shares, to acquire an invention for improvements in or relating to expansion rings for use as piston rings, to adopt an agreement with James B. Petter & Sons, Limited, and E. W. Petter, and to carry on the business of mechanical engineers, etc.

British Tool Steel Syndicate, Limited.—Capital £10,000 in £1 shares, to take over the business of a tool, steel, and general hardware merchant carried on by A. A. A. Dreyfus, as Armand Dreyfus & Cie., in Germany, Italy, Switzerland, Sweden, Norway, Austria, Hungary, Russia, Greece, Spain, and Portugal, France, and elsewhere.

Leith, Bonhote & Company, Limited.—Capital £6,250 in 5,000 preference shares of £1 each, and 25,000 deferred shares of 1s. each, to acquire the business carried on at Mansion House Chambers, E.C., as "Leith," Bonhote & Company," to carry on the business of iron founders, engineers, etc. Registered office: Queen Victoria Street, E.C.

H. Smethurst Ventilating and Engineering Company, Limited.—Capital £10,000 in £1 shares, to take over the business of ventilating engineers, etc., carried on by Herbert Smethurst & Company, Limited, of Butler Green Metal Works, Hollinwood, and to adopt an agreement with H. Smethurst, E. Tomlinson, W. Yardley, and J. W. Collin. Registered office: 25, Queen Street, Oldham.

Patent Wood Pipe and Tube Company, Limited.—Capital £5,000 in £1 shares. to adopt an agreement with H. P. Hansen, J. Hutchinson, and T. Dodds (trading as the Hansen Syndicate) for the acquisition of a certain invention relating to the manufacture of pipes from wood shavings, and to carry on the business of makers of patent wood pipes and tubes, etc. Registered office: 69, The Close, Newcastle-on-Tyne.

George Fletcher & Company, Limited.—Capital £85,000 in £1 shares (20,0000 6 per cent. cumulative preference), to take over the business of engineers, ironfounders, millwrights, etc., carried on as George Fletcher & Company, at Masson and Atlas Works, Litchurch, Derby, and 21, Mincing Lane, E.C., and to adopt an agreement with R. H. H. Marsh and F. C. Marsh. Registered office: 21, Mincing Lane, E.C.

The "F.T.J." Bookshelf.

THE CONSTRUCTION OF THE BALANCE. By Dr. E. Brauer. Published by the Incorporated Society of Inspectors of Weights and Measures.

The third edition of Dr. Brauer's work, revised by Mr. Fr. Lawaczeck, D.E., of the Technical High School at Brunswick, and translated by Mr. H. C. Walters, Inspector of Weights and Measures for West Suffolk, deals in a thorough and scientific manner with the construction of instruments for weighing. Those who are familiar with Dr. Brauer's original "Konstruktion der Wage" will well appreciate the value of this translation, particularly in view of the scarcity of literature on the subject. The book is divided into Part I., dealing with "The Balance and Weighing in General"; Part II., "Geometrical and Mechanical Properties of the Various Weighing Mechanisms"; Part III., "The Most Important Details of Balances," and Part IV., giving descriptions of balances for various purposes. In each section the subject is thoroughly well treated, and as is indicated by the title of Part II., the conclusions of that portion of the work turn upon the kinds of mechanisms employed, while in Part VI., the special purpose for which weighing instruments are used, is taken as the basis for investigation. This latter part discusses the details of only such instruments as have been proved to be really practical, or of which the construction is of such general value as to be suitable for notice.

METALLURGY OF THE COMMON (NON-FERROUS) METALS. By A. Humbolt Sexton, F.I.C., F.C.S., etc., and John S. G. Primrose, A.G.T.C., etc. Manchester: The Scientific Publishing Company.

The exhaustive treatment which has been accorded to various common non-ferrous metals by different authors rather tends to dwarf the importance of a work which, in one volume of less than 500 pages, deals with the metallurgy of a number of these metals. But it must be explained that this book is only intended as an introduction. The requirements of those engaged in metallurgical work will be better met by the larger works, a list of which is given by the authors, for it is obviously impossible in the space occupied to deal fully with the metallurgy of each metal. For instance, antimony occupies twelve pages only, whereas another author finds sufficient material to fill a complete volume on the subject. Similarly other metals are only dealt with briefly, though copper comes in for much fuller treatment. This is only meet, in view of the extensive and varied uses to which that metal is put and the number of processes employed for extracting and refining it. In fact, about one-third of the book is devoted to the subject of copper, including the mineral, the principles of copper smelting, processes for treating the ore, and refining processes. The subject of tin is summarised in about 40 pages, and then follow zinc, lead, antimony, aluminium, and nickel. It may be suggested that in such a work it would have been well to include some information on other of the metals which, while scarcely classed as common, yet are in more or less extensive commercial use. That, however, is beside the point now, for the authors have set the limitation and have worked within it, producing a book which is certainly an excellent introduction to fuller works. Naturally, there has been made little attempt to offer original matter; rather has existing information been gathered together and condensed into one volume. This, we may say, is one of the leading characteristics of the work, and the most important features of the metallurgical processes dealt with are thus presented in a concise and systematic way.

Personal.

MR. F. R. ATKINSON has resigned his directorship of the firm of Hawthorn, Leslie & Company, Limited.

MR. JOHN FRITZ, past-president of the Am.Soc.M.E., has given £10,000 to Lehigh University for an engineering laboratory.

MR. DUNCAN SHEDDEN, of Dudley, has been appointed manager of the business of Hill & Smith, Limited, of Brierley Hill, Staffs.

THE REV. T. G. BONNEY, Professor of Geology at the London University College, has been elected President of the British Association for the ensuing year.

THE late Mr. Thomas Nield Robinson, J.P., chairman of Messrs. Thomas Robinson & Son, Limited, left estate of the gross value of £75,358, with net personalty £50,783.

MR. T. W. WARD, of Albion Works, Sheffield, and Mr. Joseph Dixon, vice-president of the Sheffield Chamber of Commerce, have gone for a tour round the world on behalf of the Chamber.

DR. A. RUSSELL has been appointed Principal of the Electrical Standardising, Testing, and Training Institution, Faraday House, Southampton Row, W.C., in succession to the late Mr. H. E. Harrison.

THE late Mr. W. Peech, of Steel, Peech & Tozer, Limited, Phœnix Steel Works, Attercliffe, Sheffield, left estate of the gross value of £533,699 1s. 7d., of which the net personalty has been sworn at £527,915 6s. 2d.

MR. G. B. WALKER has been appointed secretary of the Midland Institute of Mining, Civil, and Mechanical Engineers, and in future all communications should be addressed to him at 16, Foster's Buildings, Sheffield.

MR. HAROLD HEATH GRAY, M.S.C., formerly demonstrator in metallurgy in the Guild University of Montreal, has been appointed demonstrator and research assistant in fuel and metallurgy at Leeds University.

MR. ARNOLD HARTLEY GIBSON, senior demonstrator and assistant lecturer on engineering and lecturer on hydraulics in Victoria University, Manchester, has been appointed to the chair of engineering at Dundee University College, in room of Professor Fidler, resigned.

MR. H. G. WHITE has resigned his position of chief engineer of the Sterling Telephone and Electric Company, of 200, Upper Thames Street, E.C., to become manager of the electrical department of the Soho Metal and Scientific Instrument Company, 21, St. Anne's Court, Wardour Street, W.

MR. E. G. FLEMING, Australian representative of Siemens Brothers Dynamo Works, Limited, has been transferred to India, and will be succeeded by Mr. W. M. Arnot, who was at one time engineer for the Allegemeine Electric Company in Melbourne. Both Mr. Fleming and Mr. Arnot have lately been in London.

MR. HENRY ADAMS has been elected president of the Council of the Association of Engineers-in-Charge, in succession to Mr. James Swinburne, and an attractive programme has been drawn up for the new session, including some good papers and several social functions. Among the members of the Association, Mr. Adams is one of the oldest of the engineers-in-charge, having so far back as 1865 been in responsible charge in the outdoor department of Sir W. G. Armstrong & Company, of Elswick Works.

MESSRS. JOHN I. THORNYCROFT & COMPANY, having disposed of their Chiswick Works, announce the transference of their head office to Caxton House, Westminster, S.W. The marine motor, stationary motor, and motor launch sales department will also be situated at Caxton House. The company have acquired a large and well-equipped garage and repairing works at 5-11, Vauxhall Bridge Road, S.W.

MOULDING MACHINES
OF EVERY DESCRIPTION.

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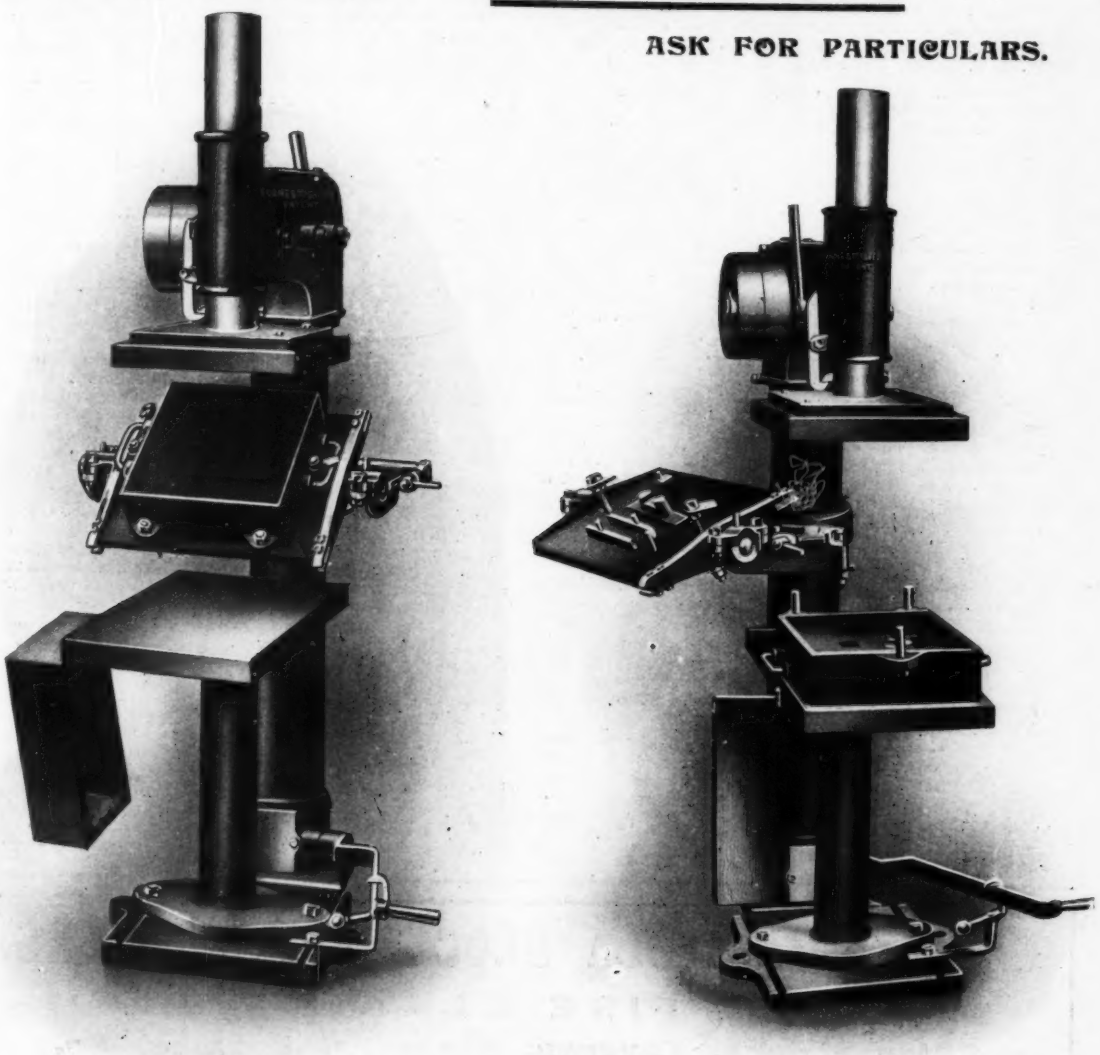

EVERYTHING FOR YOUR FOUNDRY.

JAMES EVANS & CO.,
Britannia Works, BLACKFRIARS, MANCHESTER.

Deaths.

MR. H. F. TAYLOR, of Taylor & Sons, Limited, engineers and ironfounders, Briton Ferry, and a director of the Villiers Tinplate Company, Limited, died recently.

THE death took place suddenly, at Ardenlea, Gerard Avenue, Parkhead, Glasgow, on September 4, of Mr. Anderson, manager of the Carntyne Iron Company, aged 58 years.

MR. H. DARLINGTON, for many years general manager of the now extinct business of Messrs. Boulton & Watt, Soho Foundry, Birmingham, died recently, aged 66 years. The works are now in the occupation of W. & T. Avery, Limited.

THE death took place recently, of Mr. George Glaze, of Ketley House, Kingswinford, who had a lifelong connection with the ironfoundry trade in the district, having first carried on business at Corbyn's Hall, and during the past twenty-five years or so at the Pensnett Foundry. Death occurred after an illness which commenced some twelve months ago, the deceased's age being 60 years.

HERR CARL MENSHAUSEN, who died on July 21, at Düsseldorf, was a member of the board of supervision of the Fried. Krupp Actien Gesellschaft. He was born at Pless in Upper Silesia in 1847, and became associated with the firm of Krupp in 1877. Two years later he was sent to organise the representation of the firm in China, and returned *viâ* Japan and America. Subsequently he resided in Paris and then at Düsseldorf, his scope growing more and more in relation to transactions with foreign Governments in regard to war material. In 1893 Herr Menshausen entered the directorate of the firm, and remained a member for 12 years, but considerations of health compelled him to relinquish this position in 1905. The deceased gentleman was also associated with the boards of supervision of several other companies in Germany.

WE understand that the forge masters on the Tyne and Wear have arranged to form a local association to regulate certain prices in their industry.

AFTER half a century's operations the Medway Engineering Works, Rochester, belonging to Mr. W. R. Taylor, have been closed and the staff discharged. It is stated that the late severe depression in trade is the cause of the stoppage.

APPLEBYS, LIMITED, of Parkhead, Glasgow, have erected a new constructional shop adjoining their works at Parkhead. The shop is 150 ft. long, 60 ft. wide, and 33 ft. high, while the roof is ridged, having a rake of 1 in 2½. The shop is fitted with one of Messrs. Applebys' well-known electric overhead travelling cranes of 10 tons capacity.

Parliamentary Notes.

Labour Exchanges.

In the House of Commons, last month, MR. JOWETT asked the President of the Board of Trade if he intended to publish particulars relating to the appointments of the organisation of a system of labour exchanges, and, if so, whether he would allow a reasonable time to elapse before the applications were dealt with, in order to give opportunity for persons possessing the necessary qualifications to apply. MR. TENNANT, who replied, said: The appointments referred to are as follows:—

	Salary. £ £
(1) Superintendents of Class A exchanges	250 to 350
(2) " " B "	200 to 250
(3) " " C "	150 to 200
(4) " " Sub-offices	100 to 150
(5) Registration clerks at somewhat lower salaries.	

The Committee of Selection is expected to commence work towards the end of this month.

MR. SUMMERBELL also asked the President of the Board of Trade if he was yet in a position to state the number of labour exchanges it was proposed to set up under the heads A, B, C, and the towns in which such exchanges would be located. MR. CHURCHILL: The number and allocation of labour exchanges of the various grades to be established is not finally decided, but so far as can be foreseen at present the number of Class A exchanges will be from 30 to 35, and of Class B exchanges somewhat larger. Ultimately there will also be a considerable number of smaller exchanges, sub-offices, and waiting rooms. As a general rule towns with over 100,000 inhabitants will have a Class A exchange.

Gun Mounting Orders.

In the House of Commons, last month, MR. JOWETT asked the First Lord of the Admiralty if the orders had been placed for gun-mountings for the two November ships, and for guns and gun-mountings for the four additional ships. MR. MCKENNA replied that orders for gun-mountings for the two November ships and for one of the four additional ships had been placed.

MR. GRETTON: Have the Admiralty yet completed their consideration as to when they will place the gun-mounting orders for the remaining three ships? MR. MCKENNA: We are perfectly ready to place the orders, but we shall not do so until it is considered necessary in order to complete the ships within the time named.

MR. A. LEE: Will the right hon. gentleman say with what firms the orders have been placed, particularly as to the Coventry Ordnance Works, Limited? MR. MCKENNA: It is with the Coventry Ordnance Works, Limited, that the orders for the gun-mountings for one of the four additional ships have been placed.

GANISTER, CUPOLA BLOCKS, FIRE BRICKS,
FIRE CLAY.
Silica Bricks, Tuyeres, Stoppers, Nozzles, &c.
STEEL MOULDERS' COMPOSITION, SILICA CEMENT.
J. GRAYSON LOWOOD & Co., Ltd.,
DEEPCAR, nr. SHEFFIELD.
Telegrams: "LOWOOD, DEEPCAR."

SOUND

STRONG, CLOSE-GRAINED

CASTINGS

Obtained by using

"TITANIUM THERMIT"

TINS READY FOR USE. **ALL SIZES from 2 cwt. to 20 tons.**

Prices and Particulars from

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Telephone: 3749 Central.

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Works: **210a, Bow Rd., E.**

ELDERS FOUNDRY COKE

AS SUPPLIED TO THE BRITISH ADMIRALTY DOCKYARDS.

The following, selected from numerous letters, are eminent testimony as to the quality of our celebrated "A.A.A." Coppee Foundry Coke, carefully selected, and despatched in sheeted wagons.

From PECKETT & SONS, Bristol.

Bristol, October 25th, 1904.

We have been using your Selected Foundry Coke for some considerable time.
We have pleasure in stating that we are very pleased with it, as we find we get sounder and cleaner castings, more free from blowholes and other defects, than we formerly did.

From BOW, McLACHLAN & CO., LTD. (Paisley Foundry), Paisley, Glasgow.

Paisley, 12th March, 1909.

We have yours of 4th inst., and in reply have pleasure in stating that we have been using your Foundry Coke for several years for special purposes with highly satisfactory results.

Elders Navigation Collieries, Ltd., Cardiff.

PRICES OF METALS.

The following table shows the approximate latest prices and position of stocks of metals during the past two years :—

METALS.	End Sept., 1909.	End Sept., 1908.
Iron—Scotch pig warrants ton	58/4½	*56/0
—Middlesbro' warrants ton	52 7½	57 3½
—W.C. M/nos Bessemer ... ton	63 0	61 6
—Stock, Scotch ... ... tons	1,000	1,000
Copper—Chili bars, GMB ton	£59 7 6	£59 17/6
—Stock, Europe and afloat tons	193,851	50,277
Tin—English ingots ... ton	£137 0 0	£134 10/0
—Straits ... ... ton	£138 0 0	£133 17/6
—Stock, London, Holland, U.S.A., and afloat ...tons	22,025	18,311
Lead—English pig ... ton	£13 10 0	£13 12/6
Spelter—Ord. Silesian ... ton	£23 5 0	£19 15 0
Quicksilver (75lb)... bottle	£8 7 6	£8 5 0
Antimony—Regulus ton	£30 0/0	£31 10/0 £32 10/0

* Settlement price. † Sept. 30th. ‡ Sept. 30th.

CASTINGS.

In the Cleveland district the following are the nominal rates current for castings :—

	£ s. d.		£ s. d.
Columns (plain)	6 10 0	to	6 15 0
Pipes, 1¼ to 2½ in.	4 17 6	to	5 2 6
,, 3 to 4 in.	4 10 0	to	5 0 0
,, 5 to 8 in.	4 7 6	to	4 10 0
,, 10 to 16 in.	4 7 6	to	4 10 0
,, 18 to 24 in.	4 7 6	to	4 10 0
Chairs	3 10 0	to	3 12 6
Floor plates (open sand)	3 0 0	to	3 2 6

SCRAP.

The quotations for scrap, subject to market fluctuations, are as follows:—Heavy wrought (mixed), £2 8s. 0d.; light wrought, £1 1s. 0d.; heavy cast, £2 7s. 0d.; all per ton f.o.b., London. Copper (clean), £55 0s. 0d.; brass (clean), £39 10s. 0d.; lead (usual draft), £12 10s. 0d.; tea lead, £11 10s. 0d.; zinc, £19 0s. 0d.; all per ton delivered merchant's yard.

New Catalogues.

HASLAM & SCHONTHEIL, Western Mail Chambers, Cardiff. A new price list of electric light cast-iron water-tight fittings has been issued by this Company.

S. A. WARD & COMPANY, LIMITED, Broad Street, Park, Sheffield. A card has been issued by this Company giving illustration and details of one of their types of small haulage engines, which claims as its chief features simplicity and compactness of construction.

S. N. BRAYSHAW, 2, Mulberry Street, Hulme, Manchester. Three wall cards have been issued by Mr. Brayshaw containing (1) decimal equivalents, (2) millimetre equivalents, and (3) Centigrade and Fahrenheit comparisons. They are arranged for hanging in the office in a convenient position for reference.

J. PARKINSON & SON, Canal Ironworks, Shipley, Yorks. From this firm we have received a copy of their general catalogue, containing photographic views of their works and particulars regarding their "Perfect" vises, portable vise stands, tool holders, Phipps' jacks, bench drills, "Krak" lathes, "Twink" lathes, "Multi" lathes, and numerous other descriptions of machine tools.

SILICA FIRE BRICK Co.,
OUGHTIBRIDGE.

GROUND GANISTER,
WET OR DRY.

Silco Cupola Bricks, 90 % Silica.
Better than Fire-clay Bricks for Cupolas.

Established 1863.

JAS. DURRANS & SONS,

PHŒNIX WORKS, PENISTONE, Near Sheffield.

Manufacturers of all

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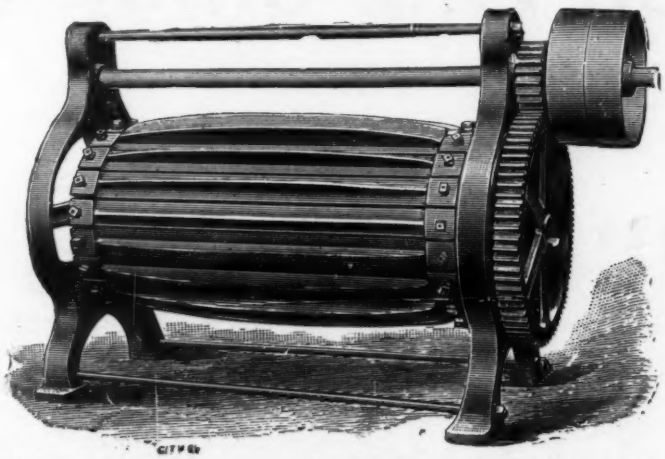

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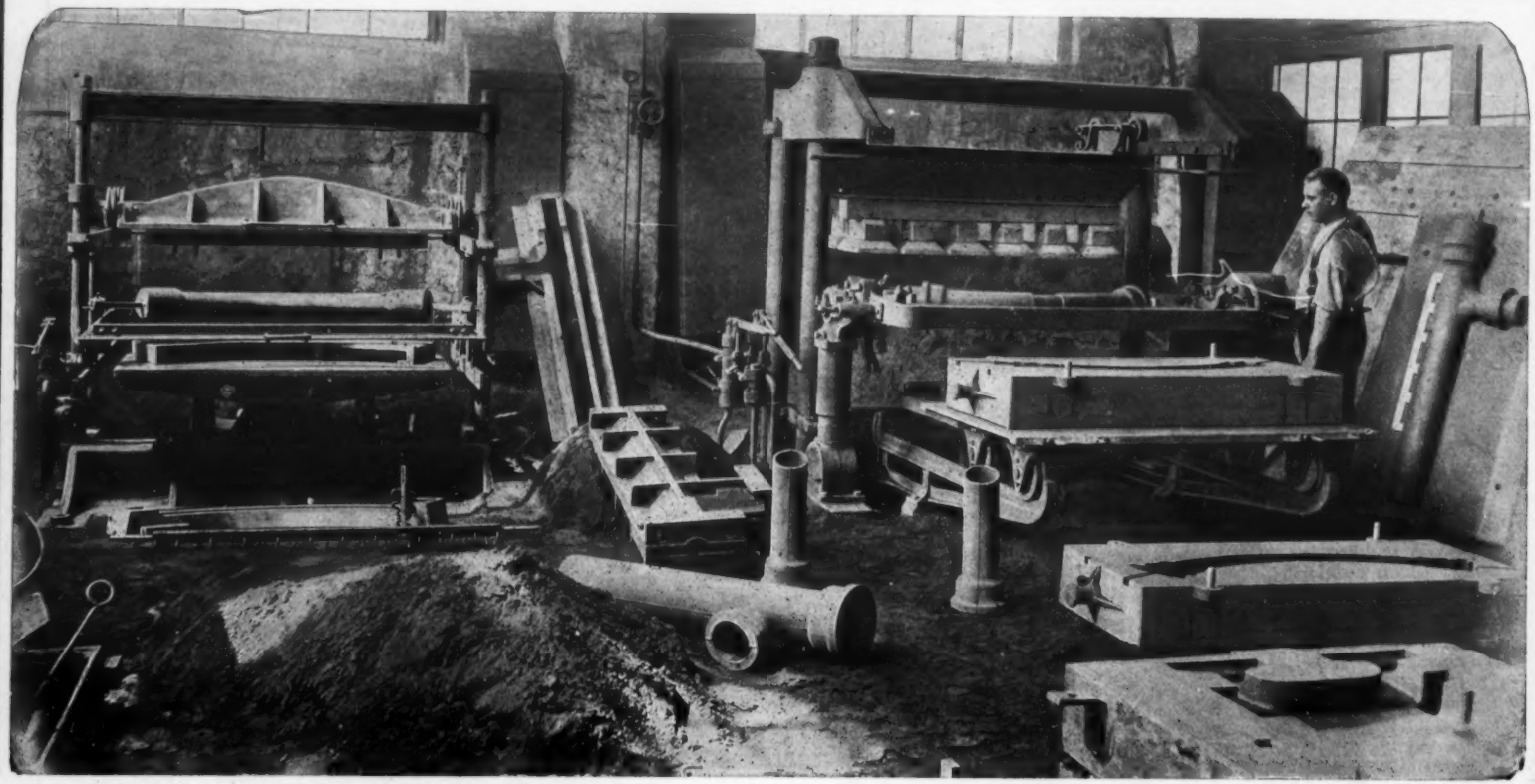

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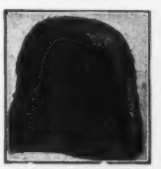

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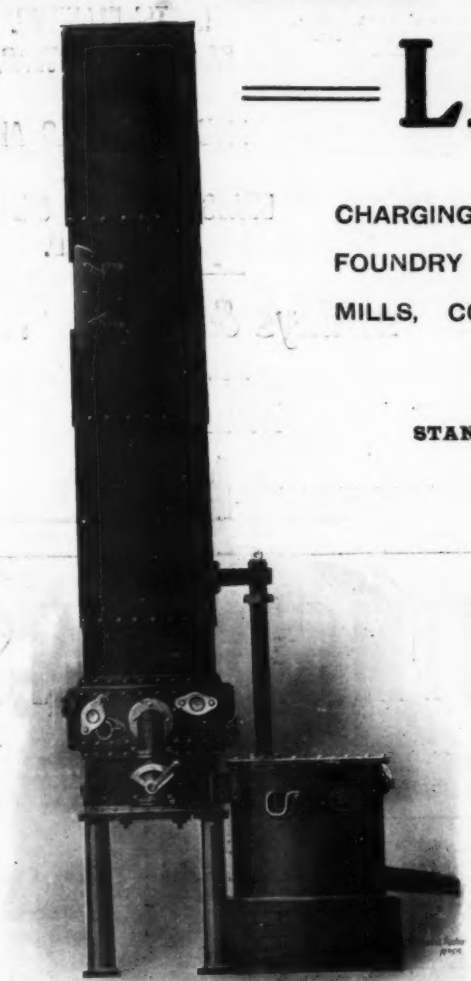

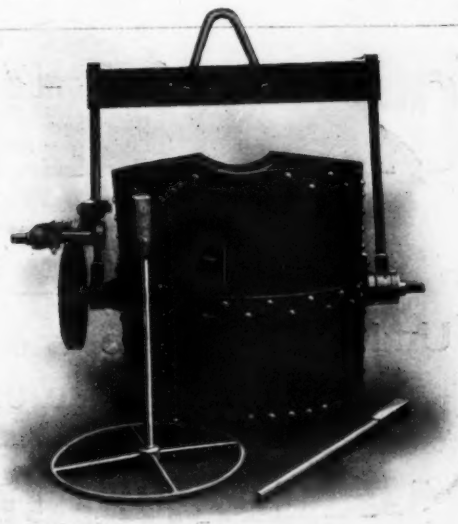

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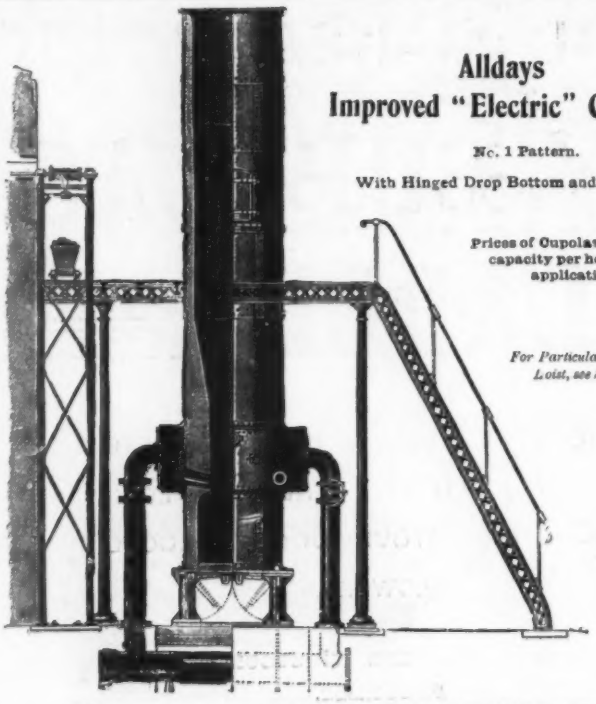

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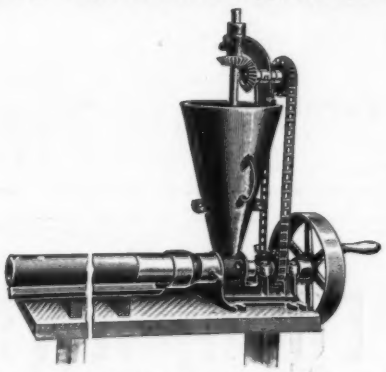

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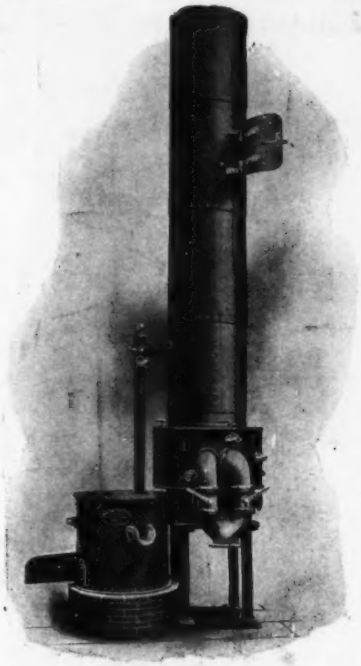

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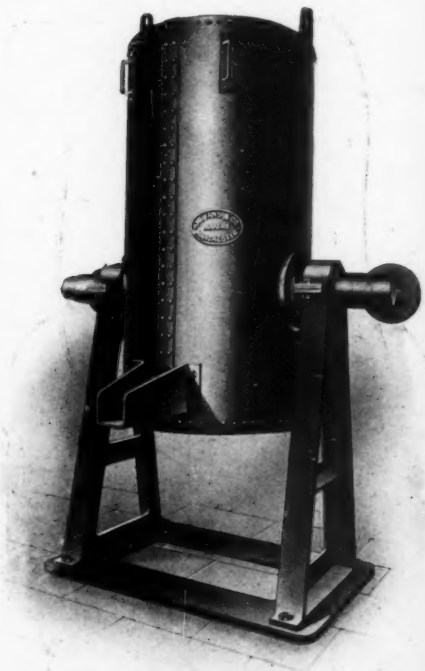

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